SECTION 5

Performance verification

Conduct these tests to verify the performance of the *700 Series Ventilator System.*

NOTE:

- The *700 Series* Ventilator System is manufactured with accurate pneumatic and electronic test equipment in a controlled environment. As field conditions vary, the accuracy of measurement devices becomes less certain.
  The following test specifications were established with the test equipment specified in Table 5-2. If the accuracies of your institution's test equipment differ from those listed, please make applicable allowances.
- The procedures in this section do not apply to ventilator accessories. Refer to operator's or service manuals of the accessories. Malfunctioning accessories may affect some ventilator functions and may result in false test results.
- Refer to this section when performing the safety checks recommended in the *700 Series Ventilator System Operator s Manual.*

5.1 When to run

Run the performance verification or portions of it after servicing the ventilator (Table 5-1).

Table 5-1: When to run performance verification

Interval or service performed	Test requirements
Every year or per your hospital's protocol	Test 1 (electrical safety test)
15,000-hour preventive maintenance	Complete performance verification
30,000-hour preventive maintenance	Complete performance verification
Removal/replacement of line filter, circuit breaker, power switch, power supply, or power assembly harnesses	Test 1 (electrical safety test) and test 6 (EST)
Removal/replacement of rotary encoder	Test 2 (rotary encoder test) and test 6 (EST)
Removal/replacement of piston/cylinder assembly, gear meshing, or greasing of rack	Test 5 (gas volume accuracy, breath timing, and PEEP system test) and test 6 (EST)
Removal/replacement of motor/encoder assembly, PEEP pump, or flow sensor assembly	Test 5 (gas volume accuracy, breath timing, and PEEP system test) and test 6 (EST)
Removal/replacement of oxygen regulator, oxygen solenoid assembly, oxygen regulator pressure transducer, mixing manifold, or oxygen sensor	Test 6 (EST) and test 7 (oxygen accuracy test)
Removal/replacement of safety valve assembly	Test 6 (EST) and test 9 (safety valve test)
Removal/replacement of UI display, pressure solenoid, controller, or battery backup (BBU) PCB; installation/removal/replacement of the Communications option assembly; EPROMs; or NVRAM	Complete performance verification
Removal/replacement of any other part	Test 6 (EST)

5.2 Tools, test equipment, and service materials

In addition to the tools listed in Section 1, the test equipment and materials listed in Table 5-2 are required for the performance verification.

Table 5-2: Test equipment required for performance verification

Description	Manufacturer and model or Nellcor Puritan Bennett part number
Electrical safety analyzer, capable of measuring ground resistance and leakage current	BIO-TEK Model 601 PRO or equivalent
Pneumatic calibration analyzer or equivalent devices capable of measuring oxygen percent, flow, BTPS volume, and pressure. Oxygen analyzer connector tee. Required accuracies: Flow: 2.75% of reading ±0.05 sL/min Volume: 2% of reading or ±1 digit Low pressure (-150 to +150 cmH_2O): 0.75% of reading ±0.04 cmH_2O High pressure (0 to 150 psig): 1.0% of reading ±0.1 psi Oxygen percentage: ±2% oxygen	Nellcor Puritan Bennett *PTS 2000* Performance Test System (4-074686-00) or Timeter RT-200 Calibration Analyzer, Allied Healthcare Products, Inc., 1720 Sublette Ave., St. Louis, MO 63110 USA, 1-800-444-3940. NOTE: If you use the RT-200, you also need a separate oxygen analyzer.
Digital multimeter (DMM) accurate to three decimal places	Local supplier
Multimeter patch cord set, 0.025 square receptacle (Includes red cord (P/N G-061579-00) and black cord (P/N G-061580-00))	G-061567-00 or equivalent
Ventilator breathing circuit	To use as test circuit: G-061208-00 or equivalent (adult, reusable, without heated wire) NOTE: To ensure that compliance compensation functions correctly, you must run EST or SST with the circuit configured as intended for use on the patient.
Test lung with strap	4-000612-00
Tubing kit, performance verification (Includes coupling (P/N 4-003443-00), tube junction connector (P/N 4-011521-00) (quantity of 2), and 30-cm, 3/16-in. ID x 3/8-in. OD tubing)	G-061573-00
Stopper, wye (no. 2)	G-061574-00 or local supplier
Stopper, inspiration port (no. 3)	G-061575-00 or local supplier
Oxygen source (40 to 90 psi (275 to 620 kPa))	Local supplier

Table 5-2: Test equipment required for performance verification (continued)

Description	Manufacturer and model or Nellcor Puritan Bennett part number
Static-dissipative field service kit (includes wrist strap, static-dissipative mat, and ground cord)	G-061661-00 or equivalent
ESD-safe vacuum cleaner with 0.2 µm filter (rated for photocopiers and laser printers)	Local supplier

5.3 Preliminary ventilator cleaning and inspection

Warning

To prevent disease transmission, use personal protective equipment when handling contaminated bacterial filters or other patient accessories. Refer to the *700 Series Ventilator Operator s Manual for instructions on sterilizing patient system* parts.

Caution

To prevent damage to ESD-sensitive components, always follow ESD guidelines when servicing components inside the ventilator.

NOTE:

If you find any problems during the preliminary ventilator inspection, correct them before proceeding with the performance verification. Failure to correct such problems now may affect the remainder of the performance verification.

Clean and inspect the ventilator as follows.

1. Clean ventilator exterior.
2. Remove any water from humidifier jar and dry the jar, if applicable.
3. Open and prop UI.
4. Using ESD-safe vacuum cleaner, clean interior of ventilator.
5. Remove and inspect main fan filter. Clean, vacuum, or replace as required.
6. Inspect outer gasket around lid to ensure it is not torn and that entire gasket is securely affixed to lid. Repair as needed.
7. Verify that oxygen regulator bleed port is installed to vent oxygen bleed gas through the louvers in the inspiration access panel.
8. Verify that the check valves in the air intake manifold are securely installed in the air intake manifold, and are not visibly worn or torn.
9. Verify that oxygen fitting is securely screwed into brass nut. (Brass nut will swivel, however.)

10. If you are regreasing the rack (every 15,000 hours and every time you install a new piston/cylinder assembly), inspect the rack and pinion for wear, chips, or breakage.
11. Visually inspect ventilator exterior and interior for obvious problems, such as missing or broken parts; loose assemblies; or disconnected wires, connectors, or tubing. Repair as needed.

5.4 Preliminary ventilator setup

Set up the ventilator for the performance verification as follows:

1. Install a complete Nellcor Puritan Bennett (or equivalent) ventilator breathing circuit. Verify that bacteria filters are installed.

NOTE:
A humidification device is not required for the performance verification or ventilation.

2. Connect ventilator to an oxygen source.

5.5 Preliminary pneumatic test equipment setup

To set up your pneumatic test equipment for use in the performance verification, verify that all equipment is calibrated and **sufficient warm-up time has elapsed prior to measurement.**

5.6 Performance verification procedures

To ensure systematic performance verification and logical fault diagnosis, perform these tests in the order given. If you need to repeat a test, however, the current control settings are completely defined at the beginning of each individual check.

NOTE:
- If you are running the performance verification tests in order, you need only make the ventilator settings shown in boldface.
- To locate the cause of a malfunction, note the boldfaced letter following the step and refer to the corresponding index letter in Section 5.7 ("Troubleshooting").

Follow these general guidelines when running the performance verification:

- If you note a problem during the performance verification, verify that you followed the procedures correctly before attempting to repair the ventilator.
- Verify that you correctly entered the data on the ventilator UI by listening for the audible confirmation of accepted settings and observing the appropriate display.
- When making ventilator settings, be aware that because of interrelationships between some ventilator settings, you may not always be able to make all settings in the indicated sequence.

- Use the alarm silence and alarm reset keys to restore the ventilator to the test condition. Using these keys may be necessary because of the nonstandard set of tubing connections, which may cause apnea or other alarm conditions to occur.
- Except for the alarm silence and alarm reset keys, do not change the control settings during these procedures, unless specifically instructed.
- Refer to Section 8 for required repairs. When repairs are completed, repeat the test. When the test is successful, proceed with the next test, as applicable.

NOTE:

The following procedures do not verify the performance of accessories. Verify the performance of accessories using the appropriate procedures in the applicable operator's or service manual.

Warning

Follow accepted safety procedures for electrical equipment when making connections, adjustments, or repairs.

5.6.1 Electrical safety test and power-on self-test (POST) (Test 1)

Warning

If the ventilator fails an electrical safety test, do not proceed to the next electrical safety test until you correct the problem and retest the unit.

The electrical safety test verifies that ground resistance and leakage current are within safe limits. Perform this test whenever you service the ventilator, per your hospital's requirements. The power-on self-test (POST), in conjunction with the extended self-test (EST), verifies overall ventilator performance. POST is initiated automatically whenever power to the ventilator is turned on. For additional information about POST, refer to Section 3.

1. Verify that ventilator power is off.
2. Plug ventilator into electrical safety analyzer.
3. VERIFY ground resistance is < 0.2 Ω (including power cord supplied with ventilator). These test points are suggested: potential equalization point, one of the screws securing the speaker, one of the screws on the options panel, the brass nut of the DISS oxygen inlet fitting, and one of the unpainted catches on the lid (that mates with the buckle). **See Section 5.7 A.**
4. Turn on ventilator power.
5. VERIFY that POST passes (indicated by unit displaying **Accept settings to start ventilation**). **See Section 5.7 B.**
6. VERIFY that forward and reverse current leakage to ground is <300 µA (100/115 V units) or <500 µA (220/240 V units). **See Section 5.7 C.**
7. VERIFY that main fan is operating properly. **See Section 5.7 D.**
8. Power off ventilator.
9. Unplug ventilator from electrical safety analyzer. Plug ventilator into wall outlet.

5.6.2 Rotary encoder test (Test 2)

The rotary encoder test verifies that the rotary (knob) encoder is functioning properly.

1. Verify that ventilator power is on.
2. Make these ventilator settings:

Control	Setting
Mode	A/C, VCV (SQUARE flow waveform for software revision J or later)
RESPIRATORY RATE	15 breaths/min
TIDAL VOLUME	200 mL
PEAK FLOW	30 L/min
PLATEAU	0 s
PEEP/CPAP	0 cmH_2O
% O_2	21

3. Select PEEP/CPAP.
4. Rotate knob one detent clockwise. VERIFY that the displayed PEEP/CPAP setting is 0.5 cmH_2O. **See Section 5.7 E.**
5. Continue rotating the knob nine more detents. VERIFY that for each detent the displayed PEEP/CPAP setting increases by 0.5 cmH_2O. **See Section 5.7 E.** VERIFY that after 10 detents, the PEEP/CPAP setting is 5 cmH_2O. **See Section 5.7 E.**
6. Turn off ventilator power.

5.6.3 Battery test (Test 3)

The battery test verifies that the batteries are operating correctly. Perform one of the following two tests: the external/internal battery test (Section 5.6.3.1) if the ventilator has an external battery or the internal battery test (Section 5.6.3.2) if the ventilator *does not* have an external battery.

NOTE:

If the optional external battery is not connected to the ventilator, perform the internal battery test only.

5.6.3.1 External/internal battery test

Perform this test only if the ventilator has an external battery connected.

1. Plug ventilator power cord into wall outlet.
2. Turn on power to ventilator.
3. Unplug power cord from wall outlet.
4. VERIFY that ventilator continues operating uninterrupted, that LOSS AC POWER alarm is invoked, and that ON EXTERNAL BATTERY indicator (in VENTILATOR STATUS section of UI) flashes. **See Section 5.7 F.**
5. Disconnect external battery from ventilator.
6. VERIFY that ventilator continues operating uninterrupted and that ON INTERNAL BATTERY indicator (in VENTILATOR STATUS section of UI) flashes. **See Section 5.7 F.**
7. Plug ventilator power cord back into wall outlet.
8. VERIFY that ON INTERNAL BATTERY indicator turns off within 3 seconds and that ON AC/BATTERY CHARGING indicator lights. **See Section 5.7 F.**
9. Press alarm reset key to clear CAUTION lamp and SWITCH INT BATTERY message.

5.6.3.2 Internal battery test

Perform this test only if the ventilator *does not* have an external battery connected.

1. Plug ventilator power cord into wall outlet.
2. Turn on power to ventilator.
3. Unplug power cord from wall outlet.
4. VERIFY that ventilator continues operating uninterrupted, that LOSS AC POWER alarm is invoked, and that ON INTERNAL BATTERY indicator (in VENTILATOR STATUS section of UI) flashes. **See Section 5.7 G.**
5. Plug ventilator power cord back into wall outlet.
6. VERIFY that ON INTERNAL BATTERY indicator turns off within 3 seconds and that ON AC/BATTERY CHARGING indicator lights. **See Section 5.7 G.**
7. Press alarm reset key to clear CAUTION lamp and LOSS AC POWER message.

5.6.4 Supply voltage test (Test 4)

The following procedures describe how to measure supply voltages off the pressure solenoid PCB.

Caution

To prevent possible damage to the pressure solenoid PCB, always use 0.025 square-receptacle banana plugs (see Table 5-2) when performing this test.

1. Open and prop ventilator lid.

NOTE:

The FAN FAILED ALERT alarm may be activated while the ventilator lid is open. Be sure to clear the associated code (6004) from the alert log after completing the performance verification.

2. Locate power supply/reference voltage test connector J2 on pressure solenoid PCB (Figure 5-1).

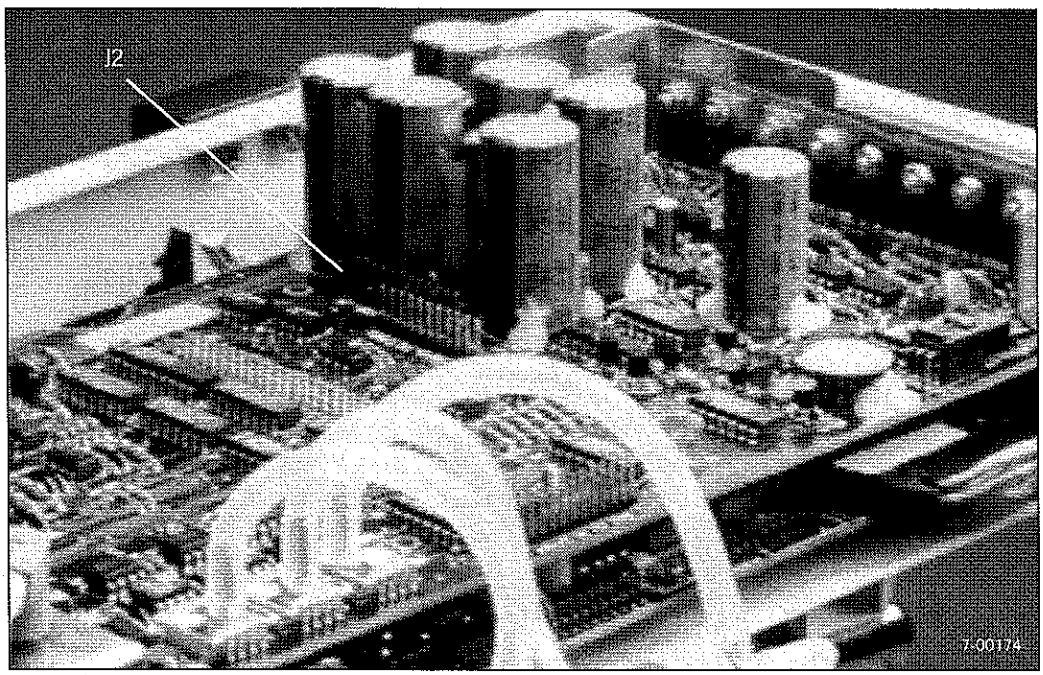

Figure 5-1. Power supply/reference voltage test connector J2 on pressure solenoid PCB

3. Connect DMM leads to each pair of pins given below, and VERIFY voltage readings given in Table 5-3. **See Section 5.7 I, J, K, L, M, N.**

Table 5-3: Pressure solenoid PCB test connector (J2) voltages

Voltage	Positive lead	Negative lead	Acceptable range
+24 V	1	12	23.00 to 25.00 V
-15 V	2	12	-15.27 to -14.09 V
+5 V	4	12	4.92 to 5.08 V
+1.2 V	5	12	1.23 to 1.24 V
UI-5 V	7	12	4.8 to 5.2 V
+15 V	11	12	14.32 to 15.57 V

4. Remove leads from test connector, and close ventilator lid.

5.6.5 Gas volume accuracy, breath timing, and PEEP system test (Test 5), using the RT-200 Pneumatic Calibration Analyzer

This test verifies the accuracy of the volume of gas delivered to the patient. It also verifies the breath timing and PEEP system.

1. When using the RT-200 Pneumatic Calibration Analyzer, set up the ventilator for test as shown in Figure 5-2.

NOTE:

If the selected humidification type is *dual heated wire* or *no heated wire*, verify that the BTPS measurement function on the RT-200 is activated (do not activate the BTPS measurement function if the humidification type is *HME*).

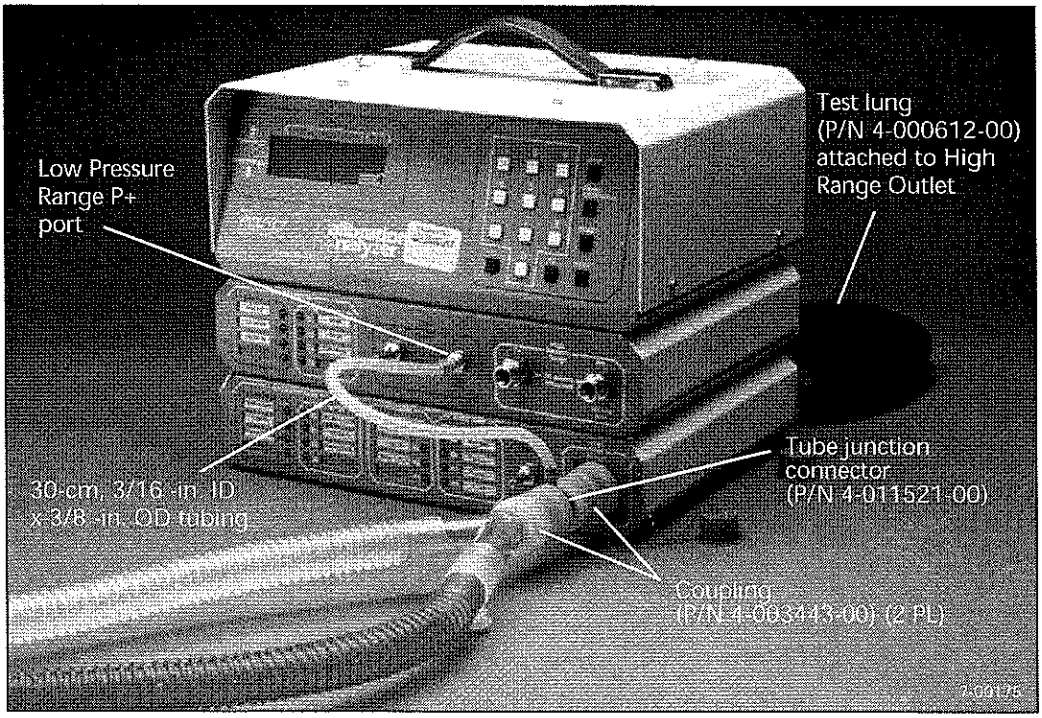

Figure 5-2. RT-200 Setup for Test 5

2. Change the ventilator settings shown in **bold**.

Control	Setting
HIGH RATE	100 breaths/min
HIGH TIDAL VOLUME	1500 mL
LOW INSP PRESSURE	3 cmH_2O
LOW TIDAL VOLUME	0 mL
HIGH PRESSURE	90 cmH_2O
LOW MINUTE VOLUME	0 L
Mode	A/C, VCV (SQUARE flow waveform for software revision J or later)
RESPIRATORY RATE	**30 breaths/min**
TIDAL VOLUME	**100 mL**
PEAK FLOW	30 L/min
PLATEAU	0 s
PEEP/CPAP	**3 cmH_2O**
TRIGGER SENSITIVITY	20 L/min
% O_2	21

3. Wait until ventilator delivers at least 10 breaths.

4. Make the following measurements, and VERIFY that the readings are as listed below. **See Section 5.7 O, P, Q.**

NOTE:

When measuring PEEP at high breath rates, the RT-200 reading fluctuates, making it difficult to take an accurate reading. To eliminate this difficulty, measure PEEP with the rate turned down to 3 breaths/min.

Measure the following	Acceptable range
Tidal volume	80 to 120 mL
Respiratory rate	29 to 31 breaths/min
PEEP	17.39 to 22.61 cmH_2O

5. Change the ventilator settings shown in **bold**.

Control	Setting
HIGH RATE	100 breaths/min
HIGH TIDAL VOLUME	1500 mL
LOW INSP PRESSURE	3 cmH_2O
LOW TIDAL VOLUME	0 mL
HIGH PRESSURE	90 cmH_2O
LOW MINUTE VOLUME	0 L
Mode	A/C, VCV (SQUARE flow waveform for software revision J or later)
RESPIRATORY RATE	**20 breaths/min**
TIDAL VOLUME	**600 mL**
PEAK FLOW	**60 L/min**
PLATEAU	0 s
PEEP/CPAP	**15 cmH_2O**
TRIGGER SENSITIVITY	20 L/min
% O_2	21

6. Make the following measurements, and VERIFY that the readings are as listed below: **See Section 5.7 O, P, Q.**

Measure the following	Acceptable range
Tidal volume	530 to 670 mL
Respiratory rate	19 to 21 breaths/min
PEEP	12.56 to 17.44 cmH_2O

7. Change the ventilator settings shown in **bold.**

Control	Setting
HIGH RATE	100 breaths/min
HIGH TIDAL VOLUME	1500 mL
LOW INSP PRESSURE	3 cmH_2O
LOW TIDAL VOLUME	0 mL
HIGH PRESSURE	90 cmH_2O
LOW MINUTE VOLUME	0 L
Mode	A/C, VCV (SQUARE flow waveform for software revision J or later)
RESPIRATORY RATE	**10 breaths/min**
TIDAL VOLUME	**1000 mL**
PEAK FLOW	**80 L/min**
PLATEAU	0 s
PEEP/CPAP	**20 cmH_2O**
TRIGGER SENSITIVITY	20 L/min
% O_2	21

8. Make the following measurements, and VERIFY that the readings are as listed below. **See Section 5.7 O, P, Q.**

Measure the following	Acceptable range
Tidal volume	890 to 1110 mL
Respiratory rate	9 to 11 breaths/min
PEEP	17.39 to 22.61 cmH_2O

9. Remove test setup, and return ventilator to original configuration.

5.6.6 Gas volume accuracy, breath timing, and PEEP system test (Test 5), using the *PTS 2000* and *Breathlab* software

This test verifies the accuracy of the volume and oxygen percentage of gas delivered to the patient. It also verifies the breath timing and PEEP system.

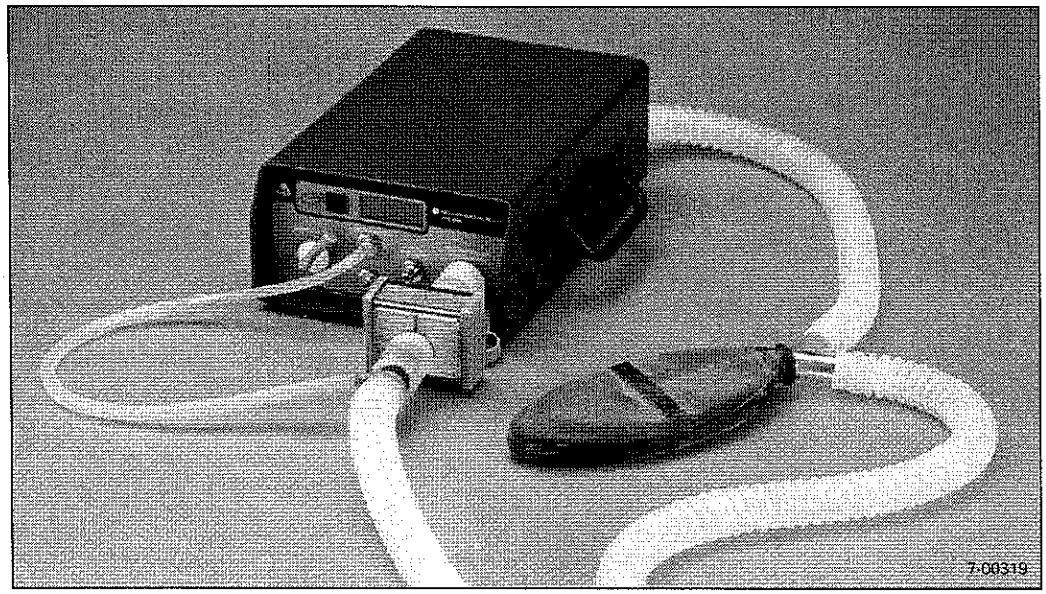

Figure 5-3. *PTS 2000* Setup for Test 5

1. When using the *PTS 2000*, set up the ventilator for test as shown in Figure 5-3:

NOTE:
Connect the *PTS 2000* with the inspiration limb of the patient tubing circuit. To ensure accurate volume measurement, place the patient wye and test lung some distance from the exhaust port of the *PTS 2000* . After installing the *PTS 2000* in the patient tubing circuit, run the SST to ensure that there are no leaks and accurately determine compliance compensation. Choose **HME** when the ventilator prompts you for the humidifier type.

NOTE:
Follow the *PTS 2000 User s Manual* instructions for setting up the unit with your computer. Set the *PTS 2000* for REMOTE OPERATION.

NOTE:
When using *PTS 2000 Breathlab* software to measure volume readings, select the *Volume (1 breath)* screen. Use the following settings: Units of measure in **mL**. Mode **ATP** threshold of **10 lpm**. Select multi and activate the arrow button to begin gathering data on each breath.

Measure PEEP in the *Low Pressure screen.* Measure oxygen percentage in the *% Oxygen* screen or the *All parameters* screen.

2. Change the settings shown in bold.

Control	Setting
HIGH RATE	100 breaths/min
HIGH TIDAL VOLUME	1500 mL
LOW INSP PRESSURE	3 cmH_2O
LOW TIDAL VOLUME	0 mL
HIGH PRESSURE	90 cmH_20
LOW MINUTE VOLUME	0 L
Mode	A/C, VCV (SQUARE flow waveform for software revision J or later)
RESPIRATORY RATE	**30 breaths/min**
TIDAL VOLUME	**100 mL**
PEAK FLOW	**30 L/m**
PLATEAU	0 s
PEEP/CPAP	**3 cmH_2O**
TRIGGER SENSITIVITY	20 L/min
% O_2	21 %

3. Wait until the ventilator delivers at least 10 breaths.
4. Make the following measurements, and VERIFY that the readings are as listed below. **See Section 5.7 O, P, Q.**

NOTE:
When making PEEP measurements at high rates the readings will fluctuate, making it difficult to take an accurate reading. To eliminate this difficulty, PEEP can be measured with the rate turned down to 3 breaths/min.

Measure the following	Acceptable range
Tidal volume	80 to 120 mL
Respiratory rate	29 to 31 breaths/min
PEEP	0.95 to 5.05 cmH_2O

5. Change the settings shown in **bold**.

Control	Setting
HIGH RATE	100 breaths/min
HIGH TIDAL VOLUME	1500 mL
LOW INSP PRESSURE	3 cmH_2O
LOW TIDAL VOLUME	0 mL
HIGH PRESSURE	90 cmH_20
LOW MINUTE VOLUME	0 L
Mode	A/C, VCV (SQUARE flow waveform for software revision J or later)
RESPIRATORY RATE	**20 breaths/min**
TIDAL VOLUME	**600 mL**
PEAK FLOW	**60 L/m**
PLATEAU	0 s
PEEP/CPAP	**15 cmH_2O**
TRIGGER SENSITIVITY	20 L/min
% O_2	21 %

6. Make the following measurements, and VERIFY that the readings are as listed below. **See Section 5.7 O, P, Q.**

Measure the following	Acceptable range
Tidal volume	530 to 670 mL
Respiratory rate	19 to 21 breaths/min
PEEP	12.56 to 17.44 cmH_2O

7. Change the ventilator setting shown in **bold.**

Control	Setting
HIGH RATE	100 breaths/min
HIGH TIDAL VOLUME	1500 mL
LOW INSP PRESSURE	3 cmH_2O
LOW TIDAL VOLUME	0 mL
HIGH PRESSURE	90 cmH_20
LOW MINUTE VOLUME	0 L
Mode	A/C, VCV (SQUARE flow waveform for software revision J or later)
RESPIRATORY RATE	**10 breaths/min**
TIDAL VOLUME	**1000 mL**
PEAK FLOW	**80 L/m**
PLATEAU	0 s
PEEP/CPAP	**20 cmH_2O**
TRIGGER SENSITIVITY	20 L/min
% O_2	21 %

8. Make the following measurements, and VERIFY that the readings are as listed below. **See Section 5.7 O, P, Q.**

Measure the following	Acceptable range
Tidal volume	890 to 1110 mL
Respiratory rate	9 to 11 breaths/min
PEEP	17.39 to 22.61 cmH_2O

5.6.7 Extended self-test (EST) (Test 6)

Warning

- Before running EST, you must disconnect the ventilator from the patient. Running EST while the ventilator is connected to the patient can injure the patient.
- Do not use or override a ventilator that completes EST with a fault status without first verifying its operational readiness by an independent means and determining that a patient will not be placed at risk.
- Nellcor Puritan Bennett urges medical departments to review the implications of using a ventilator that completed EST with a fault status. Nellcor Puritan Bennett recommends establishing a medical department protocol that defines the conditions under which ventilator usage is acceptable.

1. You can to run EST from the main menu or the service menu.

   To run EST from the Main menu:

   a. Turn on the ventilator. If ventilation has already begun since the ventilator was turned on, turn off the ventilator and turn it back on without starting ventilation.

   b. Press MENU, turn the knob to select **Self test**, then press ACCEPT. Turn the knob to select **Extended self test**.

   To run EST from the service menu:

   a. Press MENU while simultaneously powering on ventilator. Do not release MENU until prompted by message window.

   b. After POST is completed, press MENU again, turn knob to select **A. Service menu**, then press ACCEPT.

   c. Turn knob to select **EST**

2. Respond to prompts, referring to Section 3.
3. VERIFY that EST passes. **See Section 5.7 H.**
4. Connect test lung to patient wye, if not already connected.

5.6.8 Oxygen accuracy test (Test 7) using the RT-200

NOTE:
Verify that the oxygen analyzer is calibrated before running this test.

The oxygen accuracy test verifies the accuracy of the oxygen delivery system and confirms its monitoring ability.

1. Tee oxygen analyzer into inspiratory limb at inspiratory filter outlet.

2. Change the ventilator settings shown in **bold**.

Control	Setting
HIGH RATE	100 breaths/min
HIGH TIDAL VOLUME	1500 mL
LOW INSP PRESSURE	3 cmH_2O
LOW TIDAL VOLUME	**5 mL**
HIGH PRESSURE	90 cmH_2O
LOW MINUTE VOLUME	0 L
Mode	A/C, VCV (SQUARE flow waveform for software revision J or later)
RESPIRATORY RATE	**50 breaths/min**
TIDAL VOLUME	**100 mL**
PEAK FLOW	**30 L/min**
PLATEAU	0 s
PEEP/CPAP	**0 cmH_2O**
TRIGGER SENSITIVITY	20 L/min
% O_2	**30**

3. Wait 3 minutes for oxygen analyzer reading to stabilize. VERIFY that oxygen analyzer reads between 27 and 33% and that no oxygen alarms activate (if applicable). **See Section 5.7 R.**

4. Change the ventilator settings shown in **bold.**

Control	Setting
HIGH RATE	100 breaths/min
HIGH TIDAL VOLUME	1500 mL
LOW INSP PRESSURE	3 cmH_2O
LOW TIDAL VOLUME	5 mL
HIGH PRESSURE	90 cmH_2O
LOW MINUTE VOLUME	0 L
Mode	A/C, VCV (SQUARE flow waveform for software revision J or later)
RESPIRATORY RATE	**20 breaths/min**
TIDAL VOLUME	**600 mL**
PEAK FLOW	**60 L/min**
PLATEAU	0 s
PEEP/CPAP	0 cmH_2O
TRIGGER SENSITIVITY	20 L/min
% O_2	**60**

5. Wait $1\frac{1}{2}$ minutes for oxygen analyzer reading to stabilize. VERIFY that oxygen analyzer reads between 57 and 63%, and that no oxygen alarms activate (if applicable). **See Section 5.7 R.**

6. Change the ventilator settings shown in **bold.**

Control	Setting
HIGH RATE	100 breaths/min
HIGH TIDAL VOLUME	1500 mL
LOW INSP PRESSURE	3 cmH_2O
LOW TIDAL VOLUME	5 mL
HIGH PRESSURE	90 cmH_2O
LOW MINUTE VOLUME	0 L
Mode	A/C, VCV (SQUARE flow waveform for software revision J or later)
RESPIRATORY RATE	**10 breaths/min**
TIDAL VOLUME	**1000 mL**
PEAK FLOW	**80 L/min**
PLATEAU	0 s
PEEP/CPAP	0 cmH_2O
TRIGGER SENSITIVITY	20 L/min
% O_2	**100**

7. Wait $1^1/_2$ minutes for oxygen analyzer reading to stabilize. VERIFY that oxygen analyzer reads between 97 and 100%, and that no oxygen alarms activate (if applicable). **See Section 5.7 R.**
8. Remove oxygen analyzer and tee, and return inspiratory limb to previous configuration.

5.6.9 Oxygen accuracy test (Test 7) using the *PTS 2000*

NOTE:
Verify that the oxygen analyzer is calibrated before running this test.

The oxygen accuracy test verifies the accuracy of the oxygen delivery system and confirms its monitoring ability.

1. Change the ventilator settings shown in **bold**.

Control	Setting
HIGH RATE	100 breaths/min
HIGH TIDAL VOLUME	1500 mL
LOW INSP PRESSURE	3 cmH_2O
LOW TIDAL VOLUME	5 mL
HIGH PRESSURE	90 cmH_2O
LOW MINUTE VOLUME	0 L
Mode	A/C, VCV (SQUARE flow waveform for software revision J or later)
RESPIRATORY RATE	**50 breaths/min**
TIDAL VOLUME	**100 mL**
PEAK FLOW	**30 L/min**
PLATEAU	0 s
PEEP/CPAP	0 cmH_2O
TRIGGER SENSITIVITY	20 L/min
% O_2	**30**

2. Wait 3 minutes for oxygen analyzer reading to stabilize. VERIFY that oxygen analyzer reads between 27 and 33% and that no oxygen alarms activate (if applicable). **See Section 5.7 R.**

3. Change the ventilator settings shown in **bold.**

Control	Setting
HIGH RATE	100 breaths/min
HIGH TIDAL VOLUME	1500 mL
LOW INSP PRESSURE	3 cmH_2O
LOW TIDAL VOLUME	5 mL
HIGH PRESSURE	90 cmH_2O
LOW MINUTE VOLUME	0 L
Mode	A/C, VCV (SQUARE flow waveform for software revision J or later)
RESPIRATORY RATE	**20 breaths/min**
TIDAL VOLUME	**600 mL**
PEAK FLOW	**60 L/min**
PLATEAU	0 s
PEEP/CPAP	0 cmH_2O
TRIGGER SENSITIVITY	20 L/min
% O_2	**60**

4. Wait $1^1/_2$ minutes for oxygen analyzer reading to stabilize. VERIFY that oxygen analyzer reads between 57 and 63%, and that no oxygen alarms activate (if applicable). **See Section 5.7 R.**

5. Change the ventilator settings shown in **bold.**

Control	Setting
HIGH RATE	100 breaths/min
HIGH TIDAL VOLUME	1500 mL
LOW INSP PRESSURE	3 cmH_2O
LOW TIDAL VOLUME	5 mL
HIGH PRESSURE	90 cmH_2O
LOW MINUTE VOLUME	0 L
Mode	A/C, VCV (SQUARE flow waveform for software revision J or later)
RESPIRATORY RATE	**10 breaths/min**
TIDAL VOLUME	**1000 mL**
PEAK FLOW	**80 L/min**
PLATEAU	0 s
PEEP/CPAP	0 cmH_2O
TRIGGER SENSITIVITY	20 L/min
% O_2	**100**

6. Wait $1^1/_2$ minutes for oxygen analyzer reading to stabilize. VERIFY that oxygen analyzer reads between 97 and 100%, and that no oxygen alarms activate (if applicable).

5.6.10 High pressure alarm test (Test 8) using the RT-200

The high pressure alarm test verifies that ventilator breathing circuit pressure is limited within specifications.

1. Change the ventilator settings shown in **bold.**

Control	Setting
HIGH RATE	100 breaths/min
HIGH TIDAL VOLUME	1500 mL
LOW INSP PRESSURE	3 cmH_2O
LOW TIDAL VOLUME	5 mL
HIGH PRESSURE	**15 cmH_2O**
LOW MINUTE VOLUME	0 L
Mode	A/C, VCV (SQUARE flow waveform for software revision J or later)
RESPIRATORY RATE	**6 breaths/min**
TIDAL VOLUME	**1500 mL**
PEAK FLOW	**15 L/min**
PLATEAU	0 s
PEEP/CPAP	0 cmH_2O
TRIGGER SENSITIVITY	20 L/min
% O_2	**21**

2. Set pressure measurement device to read in peak/continuous mode.
3. VERIFY that pressure readings displayed on ventilator's PRESSURE bar graph, PEAK PRESSURE display, and external pressure measurement device are all between 14.1 and 15.9 cmH_2O. **See Section 5.7 S.**
4. Remove test equipment, and return ventilator to original configuration.

5.6.11 High pressure alarm test (Test 8) using the *PTS 2000*

The high pressure alarm test verifies the ventilator breathing circuit pressure is limited within specification.

1. Change the ventilator settings shown in **bold**.

Control	Setting
HIGH RATE	100 breaths/min
HIGH TIDAL VOLUME	1500 mL
LOW INSP PRESSURE	3 cmH_2O
LOW TIDAL VOLUME	5 mL
HIGH PRESSURE	**15 cmH_20**
LOW MINUTE VOLUME	0 L
Mode	A/C, VCV (SQUARE flow waveform for software revision J or later)
RESPIRATORY RATE	**6 breaths/min**
TIDAL VOLUME	**1500 mL**
PEAK FLOW	**15 L/m**
PLATEAU	0 s
PEEP/CPAP	0 cmH_2O
TRIGGER SENSITIVITY	20 L/min
% O_2	21 %

2. Set *Breathlab* software to measure to low pressure. Let the ventilator breathe at least 2 breaths.
3. VERIFY the pressure readings displayed on the ventilator's PRESSURE bar graph, PEAK PRESSURE display, and the MAX pressure reading in *Breathlab's* software are all between 14.1 and 15.9 cmH_2O.
4. Remove test equipment, and return ventilator to original configuration.

5.6.12 Safety valve test (Test 9)

The safety valve test verifies that the safety valve opens when the exhalation valve fails.

1. Verify that ventilator settings are as follows.

Control	Setting
HIGH RATE	100 breaths/min
HIGH TIDAL VOLUME	1500 mL
LOW INSP PRESSURE	3 cmH_2O
LOW TIDAL VOLUME	5 mL
HIGH PRESSURE	15 cmH_2O
LOW MINUTE VOLUME	0 L
Mode	A/C, VCV (SQUARE flow waveform for software revision J or later)
RESPIRATORY RATE	6 breaths/min
TIDAL VOLUME	1500 mL
PEAK FLOW	15 L/min
PLATEAU	0 s
PEEP/CPAP	0 cmH_2O
TRIGGER SENSITIVITY	20 L/min
% O_2	21

1. Block exhalation valve exhaust port with no. 3 stopper.
2. Block patient wye with no. 2 stopper.
3. VERIFY that safety valve opens when an inspiration is delivered. **See Section 5.7 T.**

NOTE:

For ventilators with software revision E or later, the safety valve opens then closes again when it enters occlusion cycling mode. (On ventilators with earlier software than revision E, the safety valve opens and remains open until you press ALARM RESET.)

4. Remove stoppers.
5. Remove test equipment, and return ventilator to original configuration.

5.7 Troubleshooting

NOTE:

Use the service menu *Sensor data* function (described in Section 4.2.1) to help confirm the failure of suspect components.

Use this troubleshooting information in conjunction with the performance verification tests.

These procedures are sequenced to correct the most probable malfunction or to present the most efficient corrective action first. The proposed fixes listed, however, may not always correct the particular problem.

Do not overlook problems found after this inspection, and perform the necessary repairs. The results of future tests could be affected.

NOTE:

This troubleshooting information assumes EST has passed. Use Section 3 to diagnose EST failures.

A Ground line resistance (including power cord) >0.2 Ω

a. Disconnect ventilator from electrical safety analyzer.

b. Verify that correct power cord (with grounding plug) is being used and that there is no visible damage to power cord. Check continuity of power cord. Replace power cord, as required.

c. Verify that ground wire from line filter to power tray is secure.

d. Replace power cord.

e. Replace line filter.

B POST failed

See Section 6.

C Leakage current >300 µA (100/115 V units) or >500 µA (220/240 V units)

a. Disconnect ventilator from electrical safety analyzer.

b. Verify that correct power cord and line filter are being used and that there is no visible damage to power cord. Verify that power cord has no shorts. Replace power cord, if indicated.

c. Verify secure harness connections of power input components (line filter, circuit breaker, power switch, and power supply terminal block).

d. Replace power cord.

e. Replace power input components as necessary.

D Main fan not operating properly

a. Verify correct voltage to fan (+23 to +25 V when ventilator is powered by ac). If inadequate or no voltage, troubleshoot from fan back toward power input components.

b. Verify that main fan/ventilator head harness connection is secure.

c. Replace main fan.

d. Replace pressure solenoid PCB.

E Rotary encoder test failed

a. Verify that rotary encoder cable connections are secure.

b. Verify that ventilator head/UI cable connections are secure.

c. Replace rotary encoder.

d. Replace controller PCB.

F External battery test failed

a. Verify that there is no visible damage to battery harness and connector.

b. Check external battery fuse. Replace as necessary.

c. Using *Sensor data* function in service menu, check external battery voltage. If voltage is low, charge battery and repeat test step.

d. Replace external battery.

e. Check continuity of external battery harness. Replace harness, as required.

f. Replace BBU PCB.

G Internal battery test failed

a. Verify that there is no visible damage to battery harness and connector.

b. Verify battery level. If charge is low, repeat test (Section 5.6.3.2: if battery is not charging, through step 4; if battery *is* charging, through step 6).

c. Replace internal battery.

d. Check continuity of internal battery harness. Replace harness, as required.

e. Replace BBU PCB.

H EST failed

See Section 3.

I +24 V out of range

Disconnect main ventilator head harness from pressure solenoid PCB. Disconnect BBU PCB/ventilator head harness from controller PCB, and verify that voltage between pins 36 (24V) and 31 (GND) of BBU PCB/ventilator head harness is between +23 and +25 V. If voltage is in range, replace pressure solenoid or controller PCB. If voltage is low or not present, verify +24 V output from power supply at power output terminal block. If this voltage is in range, replace BBU PCB. If this voltage is low or not present, replace power supply.

J -15 V out of range

Replace pressure solenoid PCB.

K +5V out of range

a. Replace pressure solenoid PCB.

b. Replace controller PCB.

L +1.2V out of range

Replace pressure solenoid PCB.

M UI-5V out of range

Replace UI display PCB.

N 15V out of range

Replace pressure solenoid PCB.

O Tidal volume out of range

a. Verify that test equipment used is calibrated and working correctly.

b. Verify that ventilator settings are correct.

c. Verify that all tubing connections are secure, check tubing and test lung for leaks, and verify that setup is correct.

d. Rerun SST.

e. Using *Sensor data* function in service menu, verify that atmospheric pressure (Pa) is correct. If atmospheric pressure transducer reading is incorrect, replace pressure transducer PCB.

f. Rerun EST, making sure Piston leak test passes. If test fails, replace cylinder inlet check valve.

P Respiratory rate out of range

a. Verify that test equipment used is calibrated and working correctly.

b. Verify that ventilator settings are correct, particularly that TRIGGER SENSITIVITY is set to 10 L/min.

c. Rerun SST.

Q PEEP reading out of range

a. Verify that test equipment used is calibrated and working correctly.

b. Verify that ventilator settings are correct.

c. Verify that all tubing connections are secure, and check tubing and test lung for leaks.

d. Rerun SST.

e. Recalibrate PEEP pump.

f. Replace PEEP pump inlet filter.

g. Replace PEEP pump.

R Oxygen accuracy test failed

NOTE:
Verify that the oxygen analyzer is calibrated and working correctly.

a. Make sure oxygen source pressure is between 40 and 90 psi (275 to 620 kPa).
b. Verify that ventilator settings are correct.
c. Verify that all tubing connections are secure, and check tubing and test lung for leaks.
d. Perform oxygen sensor calibration check.
e. Replace oxygen sensor.
f. Recalibrate oxygen regulator pressure sensor.
g. Replace oxygen regulator assembly.
h. Replace pressure solenoid PCB.

S High pressure alarm test failed

a. Verify that ventilator settings are correct.
b. Verify that all tubing connections are secure, and check tubing and test lung for leaks.
c. Verify that tubing between exhalation assembly, autozero solenoid, and pressure transducer is securely connected.
d. Replace pressure solenoid PCB.
e. Replace controller PCB.

T Safety valve test failed

a. Verify that safety valve/ventilator head harness connection is secure.
b. Check safety valve resistance (10.5 to 14 Ω). Replace safety valve, as required.
c. Replace safety valve.
d. Replace pressure solenoid PCB.

SECTION 6

Diagnostic codes

Use this section to interpret diagnostic codes, which are in the alert and test logs. The alert log contains codes generated by ongoing checks during ventilation. The test log contains codes generated by the power-on self-test (POST), the short self-test (SST), the extended self-test (EST), and calibrations.

The logs also contain other information that can be useful when troubleshooting the ventilator. Section 4 describes how to access and interpret these logs.

6.1 How to use this section

If the ventilator has declared a VENT INOP condition, you must repair the ventilator and then run and pass EST before ventilation can resume. To do so, first cycle power to the ventilator. The ventilator will now let you access a limited set of service menu functions only (see Section 4). Use the *EST* function to run the extended self-test. The results of the EST run, the contents of the test and/or alert logs, and other service menu functions will help you determine what to repair. (The most recently detected error (the error that triggered the VENT INOP condition) is stored in the test and/or alert log.)

Also review any other codes, all of which may help you more accurately pinpoint the failed component. Be aware, however, that some codes may represent transient failures, which may not recur. For some codes, particularly software and some hardware failures, the ventilator tries to reset itself immediately after detection of the error. The associated code will remain in memory even though the ventilator may be successfully reset. Check the time and date stamp associated with the code to determine its relevance.

If the ventilator has not declared a VENT INOP condition, and you are checking the log for other reasons, bear in mind that codes may represent transient failures that may not require repair or they may represent software or hardware errors that caused the ventilator to successfully reset itself. If the error condition causes the ventilator to declare a VENT INOP condition, then that error must be dealt with as described above.

6.2 About software errors

Many of the codes in this section represent "software errors." The software continually makes reasonableness and other data checks. If any of these checks fails, a software error is logged and the ventilator is reset, which causes POST to run. If POST does not pass, the ventilator issues up to two more system resets, waiting for POST to pass. If POST is still not passed, the ventilator declares a VENT INOP condition. As a result, the patient can breathe through the opened safety valve. Similarly, if three or more software errors are detected within 24 operating hours, the ventilator declares a VENT INOP condition.

Often, a software error is a transient failure, which is not expected to recur. When the system is reset, POST passes, and ventilation continues. If a software error recurs or if multiple software errors occur, the problem requires corrective action. Contact your regional Nellcor Puritan Bennett Technical Support.

6.3 About ventilator status (13000 series) codes

Codes in the 13000 series (ventilator status codes) provide information on:

- What the ventilator was doing at the time a ventilator reset occurred
- The overall pass/fail status SST and EST

Because a ventilator reset can be triggered by detection of an unexpected condition, a post-reset status code is often, but not always, accompanied by a code representing that triggering condition. If another code was recorded in the test log immediately before the reset code was recorded, troubleshoot the ventilator from that accompanying code. If an accompanying code was not recorded, particularly if the reset recurs, the problem requires corrective action. Contact your regional Nellcor Puritan Bennett Technical Support.

The SST and EST pass/fail status codes are for information only and do not in themselves require corrective action.

6.4 List of codes

Refer to Table 6-1 to interpret the codes in the alert and test logs. The first column lists, in numeric order, the codes. The second column lists the part of software that was running when the error was detected. The third column identifies possible causes. The fourth column suggests how to correct the condition. These procedures are sequenced to correct the most probable malfunction or to present the most efficient corrective action first. The proposed fixes listed, however, may not always correct the particular problem.

NOTE:

- Use the service menu *Sensor data* function to help confirm the failure of suspect components.
- If the listed actions do not correct an electronic problem, try replacing the controller PCB. Although replacing the controller PCB may not be listed as a corrective action, many of the ventilator's electronic circuits ultimately are controlled by that PCB.

Table 6-1: Diagnostic codes

Code	Software	Possible cause	Corrective action
1000-1177	UI application	Software error	See Section 6.2.
1178	UI application	The unit was shut down after low power was detected. The ac supply was lost and all batteries in unit are exhausted.	1. Restore ac power, if possible. 2. Replace batteries.
1179-1xxx	UI application	Software error	See Section 6.2.
2000-2xxx	UI driver	Software error	See Section 6.2.
3000-3xxx	BDMC application	Software error	See Section 6.2.
4000-4xxx	BDMC driver	Software error	See Section 6.2.
5000-5012	Interprocessor communication	Software error	See Section 6.2.
5013	Interprocessor communication	Microcontroller or other hardware failure	Replace controller PCB.
5014	Interprocessor communication	Software error Microcontroller failure	See Section 6.2. Replace controller PCB.
5015	Interprocessor communication	Microcontroller or other hardware failure	Replace controller PCB.
5016-5xxx	Interprocessor communication	Software error	See Section 6.2.
6001	Built in ongoing tests (BIOT) (technical alert -- LOSS OF POWER)	The ac supply was lost and the batteries are so low that all power may be lost. The unit will shut down in 5 minutes.	1. Restore ac power, if possible. 2. Check battery connections. 3. Replace batteries (internal and external, if installed) as necessary. 4. Replace BBU PCB.
		NOTE: Actual battery backup time remaining depends on battery condition and ventilator settings.	
6002	BIOT (technical alert -- MOTOR OVER TEMP)	Motor temperature too high	1. Clean or replace main fan filter. 2. Check for proper operation of main fan. 3. Replace motor/encoder. 4. Replace controller PCB.

Table 6-1: Diagnostic codes (continued)

Code	Software	Possible cause	Corrective action
6003	BIOT (technical alert -- CONTINUOUS HI PRES)	HIGH PRESSURE alarm is active, but circuit pressure has not dropped below HIGH PRESSURE setting. This points to a failure to open the exhalation valve.	1. Check patient; provide alternate ventilation. 2. Make sure EXHAUST port is not blocked. 3. Replace exhalation solenoid. 4. Replace pressure solenoid PCB. 5. Replace exhalation valve.
6004	BIOT (technical alert -- FAN FAILED ALERT)	Fan filter occluded or fan not operational	1. Make sure main fan is operating. 2. Make sure room temperature is not too low. Make sure that ventilator has warmed up and attained a steady-state temperature (*after* removing the ventilator from its packaging). 3. Make sure ventilator lid is securely closed and that the lid gasket is not torn. 4. Make sure vents in unit are not blocked. 5. Replace fan filter, as necessary. 6. Check that main fan/ventilator head harness connection is secure. 7. Replace main fan. 8. Replace air flow thermistor assembly.
		NOTE: Error code 6004 can be caused by a fan that draws no current *or* by insufficient air flow into the ventilator and across the air flow thermistor. If the fan is operating, the cause of this error code is insufficient air flow into the ventilator.	
6006	BIOT (technical alert -- BAT NOT CHARGING)	Battery voltage has not increased during past hour	1. Check connections and charge of batteries. 2. Replace applicable battery. 3. Replace BBU PCB.
6007	BIOT (technical alert -- SPEAKER FAILED)	Main alarm speaker failed and backup alarm sounds	1. Check wiring to speaker. 2. Replace speaker. 3. Replace pressure solenoid PCB.
6008	BIOT (technical alert -- KEYBOARD FAILED)	A key was held down longer than expected	1. Verify that keyboard cable is securely connected to UI display PCB. 2. Replace keyboard. 3. Replace controller PCB. 4. Replace UI display PCB.
		NOTE: Holding down any key other than MENU during POST causes error code 6008.	

Table 6-1: Diagnostic codes (continued)

Code	Software	Possible cause	Corrective action
6009	BIOT (technical alert -- LOW SYS TEMP ALERT)	Temperature inside ventilator enclosure too low	1. Make sure room temperature is not too low. Make sure that ventilator has warmed up and Tbox attained a steady state. 2. Replace pressure solenoid PCB.
6010	BIOT (technical alert -- HI SYS TEMP ALERT)	Temperature inside ventilator enclosure too high	1. Make sure room temperature is not too high. 2. Make sure vents in unit are not blocked. 3. Make sure main fan is operating properly. Clean or replace fan filter, as necessary. 4. Replace pressure solenoid PCB.
6011	BIOT (technical alert -- EXH CCT LOW TEMP)	Exhalation limb temperature too low	1. Check connections of exhalation heater and thermistor assemblies. 2. Replace exhalation heater assembly. 3. Replace exhalation thermistor assembly. 4. Replace pressure solenoid PCB.
		NOTE: Be aware that spirometry may be affected (monitored values may be higher than actual).	
6012	BIOT (technical alert -- EXH CCT HI TEMP)	Exhalation limb temperature too high	1. Check connections of exhalation heater and thermistor assemblies. 2. Replace exhalation heater assembly. 3. Replace exhalation thermistor assembly. 4. Replace pressure solenoid PCB.
		NOTE: Be aware that spirometry may be affected (monitored values may be higher than actual).	
6013	BIOT (technical alert -- FLO SENSOR LO TEMP)	Temperature at exhalation flow sensor pressure transducer too low	1. Make sure room temperature is not too low. Make sure that ventilator has warmed up and Txdcr attained a steady state. 2. Replace pressure solenoid PCB.
6014	BIOT (technical alert -- FLO SENSOR HI TEMP)	Temperature at exhalation flow sensor pressure transducer too high	1. Make sure room temperature is not too high. 2. Replace pressure solenoid PCB.
6015	BIOT (technical alert -- LOW BBU TEMP ALERT)	Temperature measured on BBU PCB too low	1. Replace BBU PCB. 2. Replace power supply.

Table 6-1: Diagnostic codes (continued)

Code	Software	Possible cause	Corrective action
6016	BIOT (technical alert -- HI BBU TEMP ALERT)	Temperature measured on BBU PCB too high	1. Make sure power supply fan harness is securely connected. 2. Replace power supply fan. 3. Replace BBU PCB.
6017	BIOT (technical alert -- DELIV GAS LOW TEMP)	Inspiration manifold temperature too low	1. Make sure room temperature is not too low. Make sure that ventilator has warmed up and Tdel attained a steady state. 2. Check wiring from thermistor to pressure solenoid PCB. 3. Replace inspiration manifold thermistor. 4. Replace pressure solenoid PCB.
6018	BIOT (technical alert -- DELIV GAS HI TEMP)	Inspiration manifold temperature too high	1. Make sure room temperature is not too high. 2. Check wiring from thermistor to pressure solenoid PCB. 3. Replace inspiration manifold thermistor. 4. Replace pressure solenoid PCB.
6019	BIOT (technical alert -- SERVICE XDUCER)	Exhalation, cylinder, or flow sensor pressure transducer drift	1. Make sure that ventilator has warmed up sufficiently and is at a steady-state temperature. 2. Replace pressure solenoid PCB.
6020	BIOT (technical alert -- BATTERY FUSE FAILED)	Open circuit detected in internal battery output	1. Make sure internal battery was not removed during operation. 2. Replace internal battery.
6021	BIOT (technical alert -- AIR INTAKE BLOCKED)	Ventilator has detected above-normal resistance at air intake filter during POST after power switched on.	1. Check patient. 2. Check for visible occlusions (for example, a curtain, clothing, or furniture blocking air intake). 3. Replace air intake filter.
6022	BIOT (technical alert -- REPLACE O2 SENSOR)	Oxygen sensor missing or reading out of range	1. Make sure an oxygen sensor is installed and securely connected to ventilator head harness. 2. Perform FIO_2 sensor calibration check. 3. Replace oxygen sensor.

Table 6-1: Diagnostic codes (continued)

Code	Software	Possible cause	Corrective action
6023	BIOT (technical alert -- LOW INSP PRESSURE)	Exhalation pressure transducer reading (P_e) fell below -40 cmH_2O, possibly due to a patient outdrawing the ventilator's set flow rate	1. Make sure PEAK FLOW setting is adequate to meet patient's demand. Consider appropriate LOW INSP PRESSURE and ventilator settings. 2. Check for ventilator breathing circuit disconnect. 3. Make sure air intake filter is not occluded. 4. Check reasonableness of P_e reading using *Sensor data* function while ventilation is occurring. Perform a P_e/P_{cyl} gain equalization as required. 5. Replace pressure solenoid PCB.
6024	BIOT (technical alert -- LOW INSP PRESSURE)	Inspiration pressure transducer reading (P_i) fell below -40 cmH_2O, possibly due to a patient outdrawing the ventilator's set flow rate	1. Make sure PEAK FLOW setting is adequate to meet patient's demand. Consider appropriate LOW INSP PRESSURE and ventilator settings. 2. Check for ventilator breathing circuit disconnect. 3. Make sure air intake filter is not occluded. 4. Check reasonableness of P_i and P_a readings using *Sensor data* function while ventilation is occurring. Perform a P_e/P_{cyl} gain equalization as required. Replace pressure solenoid PCB.
6025	BIOT (technical alert -- LOW INSP PRESSURE)	Cylinder pressure transducer reading (P_{cyl}) fell below -40 cmH_2O, possibly due to a patient outdrawing the ventilator's set flow rate	1. Make sure PEAK FLOW setting is adequate to meet patient's demand. Consider appropriate LOW INSP PRESSURE and ventilator settings. 2. Check for ventilator breathing circuit disconnect. 3. Make sure air intake filter is not occluded. 4. Check reasonableness of P_{cyl} reading using *Sensor data* function while ventilation is occurring. Perform a $P_e/_{cyl}$ gain equalization as required. 5. Replace pressure solenoid PCB.
6026	BIOT (technical alert -- CONTACT SERVICE)	Flow sensor offset has changed by an unexpectedly large value	1. Verify that tubes between flow sensor and pressure transducer are securely connected. 2. Make sure EXHAUST port is not blocked. 3. Check flow sensor calibration constants. 4. Replace flow sensor. 5. Replace pressure solenoid PCB.

Table 6-1: Diagnostic codes (continued)

Code	Software	Possible cause	Corrective action
6027	BIOT (technical alert -- CONTACT SERVICE)	Safety valve should be closed, but measured current is too low	1. Check that safety valve/ventilator head harness connection is secure. 2. Check safety valve resistance (10.5 to 14 Ω). 3. Replace safety valve. 4. Replace pressure solenoid PCB.
6028	BIOT (technical alert -- CONTACT SERVICE)	Safety valve should be closed, but measured current is too high	1. Check that safety valve/ventilator head harness connection is secure. 2. Check safety valve resistance (10.5 to 14 Ω). 3. Replace safety valve. 4. Replace pressure solenoid PCB.
6029	BIOT (technical alert -- CONTACT SERVICE)	No current to ALARM light when it should be on	1. Replace UI display PCB. 2. Replace controller PCB.
6030	BIOT (technical alert -- CONTACT SERVICE)	There is current to ALARM light when it should be off	1. Replace UI display PCB. 2. Replace controller PCB.
6031	BIOT (technical alert -- CONTACT SERVICE)	No current to CAUTION light when it should be on	1. Replace UI display PCB. 2. Replace controller PCB.
6032	BIOT (technical alert -- CONTACT SERVICE)	There is current to CAUTION light when it should be off	1. Replace UI display PCB. 2. Replace controller PCB.
6033	BIOT (technical alert -- CONTACT SERVICE)	Battery current low	1. Replace appropriate battery. 2. Replace BBU PCB. 3. Replace controller PCB.
6034	BIOT (technical alert -- CONTACT SERVICE)	Battery current high	1. Replace appropriate battery. 2. Replace BBU PCB. 3. Replace controller PCB.
6035	BIOT (technical alert -- CONTACT SERVICE)	PEEP pump current low	1. Verify that resistance of PEEP pump is between 12 and 15 Ω measured when pump is at ambient temperature. If it is not replace pump. 2. Check continuity of wiring to PEEP pump. Replace harness if necessary. 3. Replace pressure solenoid PCB. 4. Replace BBU PCB. 5. Replace controller PCB.

Table 6-1: Diagnostic codes (continued)

Code	Software	Possible cause	Corrective action
6036	BIOT (technical alert -- CONTACT SERVICE)	PEEP pump current high	1. Verify that resistance of PEEP pump is between 12 and 15 Ω measured when pump is at ambient temperature. If it is not replace pump. 2. Check continuity of wiring to PEEP pump. Replace harness if necessary. 3. Replace pressure solenoid PCB. 4. Replace BBU PCB. 5. Replace controller PCB.
6037	BIOT (technical alert -- AIR INTAKE ABSENT)	Air intake filter switch open.	1. Verify that air intake filter is installed and that it engages air intake filter switch. 2. Check that air intake filter switch/ ventilator head harness connection is secure. 3. Replace air intake filter. 4. Replace air intake filter switch. 5. Replace pressure solenoid PCB.
6038	BIOT (technical alert -- CONTACT SERVICE)	NVRAM failure	1. Replace NVRAM. 2. Replace controller PCB.
6039	POST (technical alert -- VALVES TEST FAILED)	Safety valve stuck closed during POST	1. Check state of safety valve during POST. If stuck closed, replace. 2. If safety valve open during POST, replace cylinder outlet check valve.
6040	Ongoing hardware checks	Nebulizer failed alert, power not being supplied to nebulizer.	1. Check cable connections between the communications panel and the nebulizer. 2. Replace the cable. 3. Check cable connections between the communications PCB and the controller PCB. 4. Replace the cable. 5. Replace communications PCB. 6. Replace the nebulizer.
6041	BIOT (technical alert -- PARTIAL OCCLUSION)	Partial occlusion in one limb of the breathing circuit.	1. Check patient. 2. Check limbs for blockages. 3. Check exhaust port for blockage. 4. Replace pressure solenoid PCB.
6042	BIOT (technical alert -- PCYL COMPARE ALLERT)	P_{cyl} transducer tube is incorrectly connected to P_i or P_e transducer.	1. Check tubing connections. 2. Replace pressure solenoid PCB.

Table 6-1: Diagnostic codes (continued)

Code	Software	Possible cause	Corrective action
6043-6046	BIOT (technical alert -- CONTACT SERVICE)	BBU signal conflict: signals indicate both battery and AC power operation.	1. Verify AC power to the ventilator. 2. Verify battery voltage. 3. Check that connections between the BBU and controller PCBs are secure. 4. Replace BBU PCB. 5. Replace controller PCB.
7000	POST	Software error	See Section 6.2.
7001	POST	Software error	See Section 6.2.
7002	POST	Software error	See Section 6.2.
7003	POST	Microcontroller or other hardware failure	Replace controller PCB.
7004	POST	Microcontroller or other hardware failure	Replace controller PCB.
7005	POST	Microcontroller or other hardware failure	Replace controller PCB.
7006	POST	Microcontroller or other hardware failure	Replace controller PCB.
7007	POST	Motor/piston failure	1. If piston/cylinder was recently replaced, make sure calibration constants were correctly input. 2. Replace motor/encoder. 3. Replace controller PCB. 4. Replace BBU PCB. 5. Replace BBU PCB/ventilator head harness. 6. Check mesh of pinion gear with rack. Remesh as necessary. 7. Replace optoswitches.
7008	POST	Motor/piston failure	1. If piston/cylinder was recently replaced, make sure calibration constants were correctly input. 2. Replace motor/encoder. 3. Replace controller PCB. 4. Replace BBU PCB. 5. Replace BBU PCB/ventilator head harness. 6. Check mesh of pinion gear with rack. Remesh as necessary. 7. Replace optoswitches.
7009	POST	A VENT INOP condition was declared.	1. See previous diagnostic codes in log for corrective actions. 2. Run EST. 3. Replace controller PCB.

Table 6-1: Diagnostic codes (continued)

Code	Software	Possible cause	Corrective action
7010	POST	Safety valve failure	1. Check that safety valve/ventilator head harness connection is secure. 2. Check safety valve resistance (10.5 to 14 Ω). 3. Replace safety valve. 4. Replace pressure solenoid PCB.
7011	POST	ALARM light failure	1. Replace UI display PCB. 2. Replace controller PCB.
7012	POST	ALARM light failure	1. Replace UI display PCB. 2. Replace controller PCB.
7013	POST	Main alarm speaker failure	1. Check speaker resistance (6 to 8 Ω). 2. Check main ventilator head harness continuity. Replace harness, as required. 3. Replace speaker. 4. Replace pressure solenoid PCB.
7014	POST	Not Ventilating signal used in UI/BD communications is not in expected state.	1. Power off ventilator. Wait 15 seconds. Power on ventilator. 2. See Section 6.2. 3. Replace controller PCB.
7015	POST	Bus monitor error	Replace controller PCB.
7016	POST	UI microcontroller failure	Replace controller PCB.
7017	POST	Software error	See Section 6.2.
7018	POST	UI clock failure	Replace controller PCB.
7019	POST	BD POST failed	Replace controller PCB.
7020	POST	BD microcontroller failure	Replace controller PCB.
7021	POST	Software error	See Section 6.2.
7022	POST	Software error	See Section 6.2.
7023	POST	Software error	See Section 6.2.
7024	POST	Software error	See Section 6.2.
7025	POST	Software error	See Section 6.2.
7026	POST	Software error	See Section 6.2.
7027	POST	Software error	See Section 6.2.
7028	POST	Controller PCB and ventilator software versions incompatible	Install controller PCB version compatible with software version.
7029	POST	Controller PCB and ventilator software versions incompatible	1. Install ventilator software version compatible with PCB version. 2. Replace controller PCB.

Table 6-1: Diagnostic codes (continued)

Code	Software	Possible cause	Corrective action
7030	POST	Pressure solenoid PCB and ventilator software versions incompatible	Install pressure solenoid PCB version compatible with software version.
7031	POST	Pressure solenoid PCB and ventilator software versions incompatible	1. Install ventilator software version compatible with PCB version. 2. Replace pressure solenoid PCB.
7032	POST	BBU PCB and ventilator software versions incompatible	Install BBU PCB version compatible with software version.
7033	POST	BBU PCB and ventilator software versions incompatible	1. Install ventilator software version compatible with PCB version. 2. Replace BBU PCB.
7034	POST	Controller PCB +1.2 V reference (for A/D converter) too low	Replace controller PCB.
7035	POST	Controller PCB +1.2 V reference (for A/D converter) too high	Replace controller PCB.
7036	POST	Controller PCB +5 V too low	Replace controller PCB.
7037	POST	Controller PCB +5 V too high	Replace controller PCB.
7038	POST	Controller PCB +2.5 V reference too low	Replace controller PCB.
7039	POST	Controller PCB +2.5 V reference too high	Replace controller PCB.
7040	POST	Cylinder pressure too low	Replace pressure solenoid PCB.
7041	POST	Cylinder pressure too high	Replace pressure solenoid PCB.
7042	POST	Exhaled flow too low	1. Make sure room temperature is not too low. Make sure that ventilator has warmed up and exhaled flow attained a steady-state temperature. 2. Replace pressure solenoid PCB.
7043	POST	Exhaled flow too high	1. Make sure room temperature is not too high. 2. Replace pressure solenoid PCB.
7044	POST	Current to PEEP pump too low	1. Replace PEEP pump. 2. Replace pressure solenoid PCB.
7045	POST	Current to PEEP pump too high	1. Replace PEEP pump. 2. Replace pressure solenoid PCB.
7046	POST	Current to safety valve too low	Replace pressure solenoid PCB.
7047	POST	Current to safety valve too high	Replace pressure solenoid PCB.
7048	POST	Exhalation pressure too low	Replace pressure solenoid PCB.
7049	POST	Exhalation pressure too high	Replace pressure solenoid PCB.

Table 6-1: Diagnostic codes (continued)

Code	Software	Possible cause	Corrective action
7050	POST	Absolute inspiration pressure too low	Replace pressure solenoid PCB.
7051	POST	Absolute inspiration pressure too high	Replace pressure solenoid PCB.
7052	POST	Piston velocity too high	1. Replace motor/encoder. 2. Replace pressure solenoid PCB. 3. Replace controller PCB.
7053	POST	Software error	See Section 6.2.
7054	POST	Software error	See Section 6.2.
7055	POST	A/D converter error	Replace controller PCB.
7056	POST	Memory error	Replace controller PCB.
7057	POST	Memory error	Replace controller PCB.
7058	POST	Memory error	Replace controller PCB.
7059	POST	Bus monitor error	Replace controller PCB.
7060	POST	Bus monitor error	Replace controller PCB.
7061	POST	Bus monitor error	Replace controller PCB.
7062	POST	Bus monitor error	Replace controller PCB.
7063	POST	A VENT INOP condition was declared.	1. See previous diagnostic codes in log for corrective actions. 2. Run EST. 3. Replace controller PCB.
7064	POST	Safety valve failure	1. Replace safety valve. 2. Replace pressure solenoid PCB.
7065	POST	ALARM light failure	1. Replace UI display PCB. 2. Replace controller PCB.
7066	POST	CAUTION light failure	1. Replace UI display PCB. 2. Replace controller PCB.
7067	POST	Main fan failure	1. Make sure main fan is operating. 2. Make sure room temperature is not too low. Make sure that ventilator has warmed up and attained a steady-state temperature. 3. Make sure ventilator lid is closed. 4. Make sure vents in unit are not blocked. 5. Clean or replace fan filter, as necessary. 6. Check that main fan/ventilator head harness connection is secure. 7. Replace main fan. 8. Replace air flow thermistor assembly.

Table 6-1: Diagnostic codes (continued)

Code	Software	Possible cause	Corrective action
7068	POST	Not Ventilating signal used in UI/BD communications is not in expected state.	1. Power off ventilator. Wait 15 seconds. Power on ventilator. 2. See Section 6.2. 3. Replace controller PCB.
7069	POST	ALARM light failure	1. Replace UI display PCB. 2. Replace controller PCB.
7070	POST	Main alarm speaker failure	1. Check wiring to speaker. 2. Replace speaker. 3. Replace pressure solenoid PCB.
7071	POST	An option panel erroneously appears to be installed.	1. Make sure option connector is disconnected. 2. Replace controller PCB.
7072	POST	An option PCB erroneously appears to be installed.	1. Make sure option connector is disconnected. 2. Replace controller PCB.
7074	POST	BBU PCB/controller PCB or UI display PCB/LCD panel connection error	1. Check that BBU PCB/controller PCB cable connections are secure. 2. Check that UI display PCB/LCD panel connections are secure. 3. Replace controller PCB. 4. Replace BBU PCB. 5. Replace UI display PCB.
7075	POST	Ventilator head connection error	1. Check that ventilator head harness/controller PCB connection is secure. 2. Replace controller PCB.
7076	POST	Rotary encoder failure or other hardware failure	1. Replace rotary encoder. 2. Replace UI display PCB. 3. Replace controller PCB.
7077	POST	Hardware failure	Replace controller PCB.
7078	POST	Hardware failure	Replace controller PCB.
7079	POST	Controller PCB and ventilator software versions incompatible	Install controller PCB version compatible with software version.
7080	POST	Controller PCB and ventilator software versions incompatible	1. Install ventilator software version compatible with PCB version. 2. Replace controller PCB.
7081	POST	Pressure solenoid PCB and ventilator software versions incompatible	Install pressure solenoid PCB version compatible with software version.
7082	POST	Pressure solenoid PCB and ventilator software versions incompatible	1. Install ventilator software version compatible with PCB version. 2. Replace pressure solenoid PCB.

Table 6-1: Diagnostic codes (continued)

Code	Software	Possible cause	Corrective action
7083	POST	BBU PCB and ventilator software versions incompatible	Install BBU PCB version compatible with software version.
7084	POST	BBU PCB revision too high for ventilator software	1. Install ventilator software version compatible with PCB version. 2. Replace BBU PCB.
7085	POST	UI display PCB +24 V too low	1. Replace UI display PCB. 2. Replace controller PCB.
7086	POST	UI display PCB +24 V too high	1. Replace UI display PCB. 2. Replace controller PCB.
7087	POST	UI display PCB +5 V too low	1. Replace UI display PCB. 2. Replace controller PCB.
7088	POST	UI display PCB +5 V too high	1. Replace UI display PCB. 2. Replace controller PCB.
7089	POST	Internal battery voltage too low	1. Replace internal battery. 2. Replace BBU PCB.
7090	POST	External battery voltage too low	1. Replace external battery. 2. Replace BBU PCB.
7091	POST	+24 V supply voltage too low	1. Check ac/battery connections. 2. Replace power supply. 3. Replace BBU PCB.
7092	POST	+24 V supply voltage too high	1. Check ac/battery connections. 2. Replace power supply. 3. Replace BBU PCB.
7093	POST	Battery current too low while charging	1. Replace applicable battery. 2. Replace BBU PCB.
7094	POST	Battery current too high while charging	1. Replace applicable battery. 2. Replace BBU PCB.
7095	POST	Battery current too low while discharging	1. Replace applicable battery. 2. Replace BBU PCB.
7096	POST	Battery current too high while discharging	1. Replace applicable battery. 2. Replace BBU PCB.
7097	POST	Controller PCB +1.2 V reference too low	Replace controller PCB.
7098	POST	Controller PCB +1.2 V reference too high	Replace controller PCB.
7099	POST	Controller PCB +1.2 V reference too low	Replace controller PCB.
7100	POST	Controller PCB +1.2 V reference too high	Replace controller PCB.

Table 6-1: Diagnostic codes (continued)

Code	Software	Possible cause	Corrective action
7101	POST	Pressure solenoid PCB +15 V too low	Replace pressure solenoid PCB.
7102	POST	Pressure solenoid PCB +15 V too high	Replace pressure solenoid PCB.
7103	POST	Pressure solenoid PCB -15 V too low	Replace pressure solenoid PCB.
7104	POST	Pressure solenoid PCB -15 V too high	Replace pressure solenoid PCB.
7105	POST	BBU PCB +15 V too low	Replace BBU PCB.
7106	POST	BBU PCB +15 V too low	Replace BBU PCB.
7107	POST	BBU PCB +5 V too low	Replace BBU PCB.
7108	POST	BBU PCB +5 V too high	Replace BBU PCB.
7109	POST	Temperature measured on BBU PCB too low	1. Make sure room temperature is not too low. Make sure that ventilator has warmed up. 2. Replace BBU PCB. 3. Replace power supply.
7110	POST	Temperature measured on BBU PCB too high	1. Make sure room temperature is not too high. 2. Make sure power supply fan harness is securely connected. 3. Replace power supply fan. 4. Replace BBU PCB.
7111	POST	Controller PCB +2.5 V reference too low	Replace controller PCB.
7112	POST	Controller PCB +2.5 V reference too high	Replace controller PCB.
7113	POST	Controller PCB +12 V reference too high	Replace controller PCB.
7114	POST	Controller PCB +12 V reference too low	Replace controller PCB.
7115	POST	Ventilator internal temperature too low	1. Make sure room temperature is not too low. Make sure that ventilator has warmed up and Tbox attained a steady state. 2. Replace pressure solenoid PCB.

Table 6-1: Diagnostic codes (continued)

Code	Software	Possible cause	Corrective action
7116	POST	Ventilator internal temperature too high	1. Make sure room temperature is not too high. 2. Make sure vents in unit are not blocked. 3. Make sure main fan is operating properly. Clean or replace fan filter, as necessary. 4. Replace pressure solenoid PCB.
7117	POST	Temperature at exhalation flow sensor pressure transducer too low	1. Make sure room temperature is not too low. Make sure that ventilator has warmed up and Txdcr attained a steady state. 2. Replace pressure solenoid PCB.
7118	POST	Temperature at exhalation flow sensor pressure transducer too high	1. Make sure room temperature is not too high. 2. Replace pressure solenoid PCB.
7119	POST	Exhalation limb temperature too low	1. Make sure room temperature is not too low. Make sure that ventilator has warmed up and exhaled gas attained a steady-state temperature. 2. Replace exhalation heater assembly. 3. Replace exhalation thermistor assembly. 4. Replace pressure solenoid PCB.
7120	POST	Exhalation limb temperature too high	1. Make sure room temperature is not too high. 2. Replace exhalation heater assembly. 3. Replace exhalation thermistor assembly. 4. Replace pressure solenoid PCB.
7121	POST	Inspiration manifold temperature too low	1. Make sure room temperature is not too low. Make sure that ventilator has warmed up and Tdel attained a steady state. 2. Check that thermistor/main ventilator head harness connection is secure. 3. Replace inspiration manifold thermistor. 4. Replace pressure solenoid PCB.
7122	POST	Inspiration manifold temperature too high	1. Make sure room temperature is not too high. 2. Check that thermistor/main ventilator head harness connection is secure. 3. Replace inspiration manifold thermistor. 4. Replace pressure solenoid PCB.
7123	POST	Inspiration pressure too low	1. Verify that tubing between inspiration manifold and pressure transducer is securely connected. 2. Replace pressure solenoid PCB.

Table 6-1: Diagnostic codes (continued)

Code	Software	Possible cause	Corrective action
7124	POST	Inspiration pressure too high	1. Verify that tubing between inspiration manifold and pressure transducer is securely connected. 2. Replace pressure solenoid PCB.
7125	POST	Exhalation pressure too low	1. Verify that tubing between exhalation assembly, autozero solenoid, and pressure transducer is securely connected. 2. Replace pressure solenoid PCB.
7126	POST	Exhalation pressure too high	1. Verify that tubing between exhalation assembly, autozero solenoid, and pressure transducer is securely connected. 2. Replace pressure solenoid PCB.
7127	POST	Exhaled flow too low	1. Make sure room temperature is not too low. Make sure that ventilator has warmed up and exhaled flow attained a steady-state temperature. 2. Replace flow sensor. 3. Replace pressure solenoid PCB.
7128	POST	Exhaled flow too high	1. Make sure exhaled gas temperature is stable. 2. Replace flow sensor. 3. Replace pressure solenoid PCB.
7129	POST	Oxygen supply pressure too low	1. Make sure oxygen source pressure is at least 40 psi. 2. Check for proper installation of oxygen regulator pressure transducer and connection of sensor to pressure solenoid PCB. 3. Calibrate oxygen regulator pressure transducer. 4. Replace oxygen regulator pressure transducer. 5. Replace pressure solenoid PCB. 6. Replace oxygen regulator assembly.
7130	POST	Oxygen supply pressure too high	1. Calibrate oxygen regulator pressure transducer. 2. Replace oxygen regulator pressure transducer. 3. Replace pressure solenoid PCB. 4. Replace oxygen regulator assembly.
7131	POST	Absolute inspiration pressure too low	Replace pressure solenoid PCB.

Table 6-1: Diagnostic codes (continued)

Code	Software	Possible cause	Corrective action
7132	POST	Absolute inspiration pressure too high	Replace pressure solenoid PCB.
7133	POST	Oxygen percentage reading too low	1. Perform *FIO2 sensor calib* function, making sure room temperature is same as expected room temperature during use. 2. Replace oxygen sensor. 3. Replace pressure solenoid PCB.
7134	POST	Oxygen percentage reading too high	1. Perform *FIO2 sensor calib* function, making sure room temperature is same as expected room temperature during use. 2. Replace oxygen sensor. 3. Replace pressure solenoid PCB.
7135	POST	Current to PEEP pump too low	1. Replace PEEP pump. 2. Replace pressure solenoid PCB.
7136	POST	Current to PEEP pump too high	1. Replace PEEP pump. 2. Replace pressure solenoid PCB.
7137	POST	Low oxygen supply pressure	1. Make sure oxygen source pressure is at least 40 psi. 2. Check for proper installation of oxygen regulator pressure transducer and connection of sensor to pressure solenoid PCB. 3. Calibrate oxygen regulator pressure transducer. 4. Replace oxygen regulator pressure transducer. 5. Replace pressure solenoid PCB. 6. Replace oxygen regulator assembly.
7138	POST	A VENT INOP condition was declared, because three soft resets occurred in a 24-hour operational period.	1. See previous diagnostic codes in log for corrective actions. 2. Run EST. 3. Replace controller PCB.
7139	POST	Software error	See Section 6.2.
7140	POST	Software error	See Section 6.2.
7141	POST	POST detected that a key was pressed when POST was run due to a soft reset. No keys should be pressed when POST is run due to a soft reset.	1. Release key. 2. Verify that keyboard cable is securely connected to UI display PCB. 3. Replace keyboard. 4. Replace controller PCB. 5. Replace UI display PCB.
7142	POST	Software error	See Section 6.2.

Table 6-1: Diagnostic codes (continued)

Code	Software	Possible cause	Corrective action
7143	POST	Software error	See Section 6.2.
7144	POST	A key was held down.	1. Release key. 2. Verify that keyboard cable is securely connected to UI display PCB. 3. Replace keyboard. 4. Replace controller PCB. 5. Replace UI display PCB.
7145	POST	Real-time clock error	Replace controller PCB.
7146	POST	Real-time clock error	Replace controller PCB.
7147	POST	BD POST did not operate as expected (possible microcontroller failure).	Replace controller PCB.
7148	POST	Software error	See Section 6.2.
7149	POST	Software error	See Section 6.2.
7150	POST	Software error	See Section 6.2.
7151	POST	Software error	See Section 6.2.
7152	POST	Software error	See Section 6.2.
7153	POST	General-purpose timer failure	Replace controller PCB.
7154	POST	Software error	See Section 6.2.
7155	POST	BD microcontroller failure	Replace controller PCB.
7156	POST	UI POST failed.	See previous diagnostic codes in log for corrective actions.
7157	POST	BD POST failed.	See previous diagnostic codes in log for corrective actions.
7158	POST	BD microcontroller clock failure	Replace controller PCB.
7159	POST	Failure to initialize UI panel	1. Replace UI display PCB. 2. Replace controller PCB.
7160	POST	Communications error (DUART device)	Replace controller PCB.
7161	POST	Communications error (DUART device)	Replace controller PCB.
7162	POST	Communications error (DUART device)	Replace controller PCB.
7163	POST	Communications error (DUART device)	Replace controller PCB.
7164	POST	Communications error (DUART device)	Replace controller PCB.

Table 6-1: Diagnostic codes (continued)

Code	Software	Possible cause	Corrective action
7165	POST	Communications error (DUART device)	Replace controller PCB.
7166	POST	Communications error (DUART device)	Replace controller PCB.
7167	POST	Communications error (DUART device)	Replace controller PCB.
7168	POST	General-purpose timer failure	Replace controller PCB.
7169	POST	Ventilator did not switch to ac after POST.	1. Verify that ac is acceptable. 2. Check LEDs on BBU PCB and power supply to determine presence of voltages. Replace BBU PCB, power supply, or power input component, as required.
7170	POST	Atmospheric pressure out of range	1. Make sure ventilator is operating within stated environmental specifications. 2. Replace pressure solenoid PCB.
7171	POST	Atmospheric pressure out of range	1. Make sure ventilator is operating within stated environmental specifications. 2. Replace pressure solenoid PCB.
7172	POST	Analog signal on UI section of controller PCB out of range	1. Replace pressure solenoid PCB. 2. Replace controller PCB.
7173	POST	Analog signal on UI section of controller PCB out of range	1. Replace pressure solenoid PCB. 2. Replace controller PCB.
7174	POST	Analog signal on BD section of controller PCB out of range	1. Replace pressure solenoid PCB. 2. Replace controller PCB.
7175	POST	Cylinder pressure too low	1. Make sure inspiratory filter is not blocked. 2. Replace pressure solenoid PCB.
7176	POST	Cylinder pressure too high	1. Make sure inspiratory filter is not blocked. 2. Replace pressure solenoid PCB.
7177	POST	Exhalation limb temperature too low	1. Make sure room temperature is not too low. Make sure that ventilator has warmed up and exhaled flow attained a steady-state temperature. 2. Replace exhalation heater assembly. 3. Replace exhalation thermistor assembly. 4. Replace pressure solenoid PCB.

Table 6-1: Diagnostic codes (continued)

Code	Software	Possible cause	Corrective action
7178	POST	Exhalation limb temperature too high	1. Make sure room temperature is not too high. 2. Replace exhalation heater assembly. 3. Replace exhalation thermistor assembly. 4. Replace pressure solenoid PCB.
7179	POST	Software error	See Section 6.2.
7180	POST	Software error	See Section 6.2.
7181	POST	Software error	See Section 6.2.
7182	POST	Multiplexer failure on pressure solenoid PCB	Replace pressure solenoid PCB.
7183	POST	Multiplexer failure on pressure solenoid PCB	Replace pressure solenoid PCB.
7184	POST	Multiplexer failure on pressure solenoid PCB	Replace pressure solenoid PCB.
7185	POST	Multiplexer failure on pressure solenoid PCB	Replace pressure solenoid PCB.
7186	POST	Multiplexer lines shorted	Replace pressure solenoid PCB.
7187	POST	Multiplexer failure	Replace pressure solenoid PCB.
7188	POST	Multiplexer failure	Replace pressure solenoid PCB.
7189	POST	Multiplexer failure	Replace pressure solenoid PCB.
7190	POST	Multiplexer failure on controller PCB	Replace controller PCB.
7191	POST	Multiplexer failure on controller PCB	Replace controller PCB.
7192	POST	Multiplexer failure on controller PCB	Replace controller PCB.
7193	POST	Multiplexer failure on controller PCB	Replace controller PCB.
7194	POST	Clock failure on controller PCB	Replace controller PCB.
7195	POST	Motor controller chipset clock failure	Replace controller PCB.
7196	POST	Failure to zero exhalation flow sensor pressure transducer	1. Make sure room temperature is not too low. Make sure that ventilator has warmed up and exhaled flow attained a steady-state temperature. 2. Replace pressure solenoid PCB. 3. Replace flow sensor. 4. Replace pressure solenoid PCB.
7197	POST	Power source indicator stuck on	Replace BBU PCB.

Table 6-1: Diagnostic codes (continued)

Code	Software	Possible cause	Corrective action
7198	POST	Power source indicator stuck on	Replace BBU PCB.
7199	POST	EPROM or other hardware failure	1. Reinstall software. 2. Replace controller PCB.
7200	POST	EPROM or other hardware failure	1. Reinstall software. 2. Replace controller PCB.
7201-7206	POST	Software error	See Section 6.2.
7207	POST	Motor temperature too high	1. Clean or replace main fan filter. 2. Check for proper operation of main fan. 3. Replace motor/encoder.
7208	POST	An area of NVRAM that is not checked by a checksum is corrupted.	1. Restore NVRAM data. 2. Replace NVRAM.
7209	POST	Software error	See Section 6.2.
7210	POST	Software error	See Section 6.2.
7211	POST	Software error	See Section 6.2.
7212	POST	VENT INOP signal is active	1. See previous diagnostic codes in log for corrective actions. 2. Run EST. 3. Replace controller PCB.
7213	POST	VENT INOP signal is active	1. See previous diagnostic codes in log for corrective actions. 2. Run EST. 3. Replace controller PCB.
7214	POST	VENT INOP signal is active	1. See previous diagnostic codes in log for corrective actions. 2. Run EST. 3. Replace controller PCB.
7215	POST	VENT INOP signal is active	1. See previous diagnostic codes in log for corrective actions. 2. Run EST. 3. Replace controller PCB.
7216	POST	VENT INOP signal is active	1. See previous diagnostic codes in log for corrective actions. 2. Run EST. 3. Replace controller PCB.
7217	POST	VENT INOP signal is active	1. See previous diagnostic codes in log for corrective actions. 2. Run EST. 3. Replace controller PCB.

Table 6-1: Diagnostic codes (continued)

Code	Software	Possible cause	Corrective action
7218	POST	VENT INOP signal is active	1. See previous diagnostic codes in log for corrective actions. 2. Run EST. 3. Replace controller PCB.
7219	POST	Operating temperature < 5 °C	Make sure room temperature is not too low. Make sure that ventilator has warmed up and exhaled flow attained a steady-state temperature.
7220	POST	Zeroing of oxygen regulator pressure transducer failed	Replace oxygen regulator pressure transducer.
7221-7233	POST	Software error	See Section 6.2.
7234	POST	Controller PCB ID invalid	Replace controller PCB.
7235	POST	Pressure solenoid PCB ID invalid	Replace pressure solenoid PCB.
7236	POST	BBU PCB ID invalid	Replace BBU PCB.
7237	POST	Loopback test performed on controller PCB during POST failed.	Replace controller PCB.
7238	POST	Loopback test performed on controller PCB during POST failed.	Replace controller PCB.
7239	POST	The voltage used to identify the *740/760* user interface is out of range.	1. Check all cable connections between the user interface and controller PCB. 2. Replace the UI display PCB. 3. Replace the controller PCB.
7240-7246	POST	Software error	See Section 6.2.
8000-8xxx	Library functions	Software error	See Section 6.2.
9000	Ongoing hardware checks	An out-of-bounds temperature measurement caused the reset	Determine which temperature was out of bounds using *Sensor data* function and referring to previous diagnostic code in log.
9001	Ongoing hardware checks	An out-of-bounds controller PCB voltage measurement caused the reset.	Replace controller PCB.
9002	Ongoing hardware checks	An out-of-bounds pressure solenoid PCB voltage caused the reset.	1. Determine which voltage is out of bounds through pressure solenoid PCB test connector. 2. Replace pressure solenoid PCB.
9003	Ongoing hardware checks	An out-of-bounds BBU PCB voltage caused the reset.	Replace BBU PCB.

Table 6-1: Diagnostic codes (continued)

Code	Software	Possible cause	Corrective action
9004	Ongoing hardware checks	Current to PEEP pump too low	1. Replace PEEP pump. 2. Replace pressure solenoid PCB.
9005	Ongoing hardware checks	Current to PEEP pump too high	1. Replace PEEP pump. 2. Replace pressure solenoid PCB.
9006	Ongoing hardware checks	PEEP pump current problem	1. Replace PEEP pump. 2. Replace pressure solenoid PCB.
9007	Ongoing hardware checks	PEEP pump current problem	1. Replace PEEP pump. 2. Replace pressure solenoid PCB.
9008	Ongoing hardware checks	Motor temperature too high	1. Clean or replace main fan filter. 2. Check for proper operation of main fan. 3. Replace motor/encoder.
9009	Ongoing hardware checks	VENT INOP signal is active	1. See previous diagnostic codes in log for corrective actions. 2. Run EST. 3. Replace controller PCB.
9010	Ongoing hardware checks	Not Ventilating signal used in UI/BD communications is not in expected state.	1. See Section 6.2. 2. Replace controller PCB.
9011	Ongoing hardware checks	Battery current too low while charging	1. Replace applicable battery. 2. Replace BBU PCB.
9012	Ongoing hardware checks	Battery current too high while charging	1. Replace applicable battery. 2. Replace BBU PCB.
9013	Ongoing hardware checks	Main fan failure	1. Make sure room temperature is not too low. Make sure that ventilator has warmed up and attained a steady-state temperature. 2. Make sure ventilator lid is closed. 3. Make sure vents in unit are not blocked. 4. Clean or replace fan filter, as necessary. 5. Check that main fan/ventilator head harness connection is secure. 6. Replace main fan. 7. Replace air flow thermistor assembly.
9014	Ongoing hardware checks	A VENT INOP condition was declared	1. See previous diagnostic codes in log for corrective actions. 2. Run EST. 3. Replace controller PCB.
9015	Ongoing hardware checks	Not Ventilating signal used in UI/BD communications is not in expected state	1. See Section 6.2. 2. Replace controller PCB.

Table 6-1: Diagnostic codes (continued)

Code	Software	Possible cause	Corrective action
9016	Ongoing hardware checks	Main alarm speaker failure	1. Check wiring to speaker. 2. Replace speaker. 3. Replace pressure solenoid PCB.
9017	Ongoing hardware checks	Safety valve current problem	1. Replace safety valve. 2. Replace pressure solenoid PCB.
9018	Ongoing hardware checks	Safety valve current problem	1. Replace safety valve. 2. Replace pressure solenoid PCB.
9019	Ongoing hardware checks	Safety valve current problem	1. Replace safety valve. 2. Replace pressure solenoid PCB.
9020	Ongoing hardware checks	Safety valve current problem	1. Replace safety valve. 2. Replace pressure solenoid PCB.
9021	Ongoing hardware checks	Safety valve failure	1. Replace safety valve. 2. Replace pressure solenoid PCB.
9022	Ongoing hardware checks	Safety valve failure	1. Replace safety valve. 2. Replace pressure solenoid PCB.
9023	Ongoing hardware checks	ALARM light failure	1. Replace UI display PCB. 2. Replace controller PCB.
9024	Ongoing hardware checks	ALARM light failure	1. Replace UI display PCB. 2. Replace controller PCB.
9025	Ongoing hardware checks	Pressure solenoid PCB serial EPROM failure	Replace pressure solenoid PCB.
9026	Ongoing hardware checks	Pressure solenoid PCB serial EPROM failure	Replace pressure solenoid PCB.
9027	Ongoing hardware checks	Pressure solenoid PCB serial EPROM failure	Replace pressure solenoid PCB.
9028	Ongoing hardware checks	Pressure solenoid PCB serial EPROM failure	Replace pressure solenoid PCB.
9029	Ongoing hardware checks	One microcontroller recognizes a power loss, but other doesn't.	Replace controller PCB.
9030	Ongoing hardware checks	Safety valve control circuit failure	1. Replace pressure solenoid PCB. 2. Replace controller PCB
9031	Ongoing hardware checks	Message window (LCD panel) failure	Replace message window (LCD panel).
9033	Ongoing hardware checks	Failure to zero exhalation flow sensor pressure transducer	1. Make sure room temperature is not too low. Make sure that ventilator has warmed up and exhaled flow attained a steady-state temperature. 2. Replace flow sensor. 3. Replace pressure solenoid PCB.

Table 6-1: Diagnostic codes (continued)

Code	Software	Possible cause	Corrective action
9034	Ongoing hardware checks	Inspiration manifold temperature out of bounds	1. Make sure room temperature is within specifications. Make sure ventilator has warmed up and Tdel attained a steady state. 2. Check that inspiration manifold thermistor/ventilator head harness connection is secure. 3. Replace inspiration manifold thermistor. 4. Replace pressure solenoid PCB.
9035	Ongoing hardware checks	Internal ventilator temperature out of bounds	1. Make sure room temperature is within specifications. Make sure ventilator has warmed up and Tbox attained a steady state. 2. Replace pressure solenoid PCB.
9036	Ongoing hardware checks	Absolute inspiratory pressure out of bounds	Replace pressure solenoid PCB.
9037	Ongoing hardware checks	Absolute inspiratory pressure out of bounds	Replace pressure solenoid PCB.
9038	Ongoing hardware checks	Inspiration pressure out of bounds	1. Use *Sensor data* function to check P_i reading. 2. Replace pressure solenoid PCB.
9039	Ongoing hardware checks	Exhalation pressure out of bounds	1. Use *Sensor data* function to check P_i reading. 2. Replace pressure solenoid PCB.
9040	Ongoing hardware checks	Exhaled flow out of bounds	1. Make sure room temperature is within specifications. Make sure that ventilator has warmed up and exhaled flow attained a steady-state temperature. 2. Replace flow sensor. 3. Replace pressure solenoid PCB.
9041	Ongoing hardware checks	Atmospheric pressure out of bounds	1. Make sure ventilator is operating within stated environmental specifications. 2. Replace pressure solenoid PCB.
9042	Ongoing hardware checks	Oxygen regulator pressure out of bounds	1. Make sure oxygen source pressure is at least 40 psi. 2. Check for proper installation of oxygen regulator pressure transducer and connection of sensor to pressure solenoid PCB. 3. Replace oxygen regulator pressure transducer. 4. Replace oxygen regulator assembly. 5. Replace pressure solenoid PCB.

Table 6-1: Diagnostic codes (continued)

Code	Software	Possible cause	Corrective action
9043	Ongoing hardware checks	Oxygen percentage reading out of bounds	1. Make sure an oxygen sensor is installed and securely connected to ventilator head harness. 2. Check remaining sensor life (via service summary) and replace sensor if required. 3. Replace oxygen regulator assembly. 4. Replace pressure solenoid PCB.
9044-9060	Ongoing hardware checks	NVRAM failure	1. See Section 6.2. 2. Restore NVRAM data. 3. Replace NVRAM.
9061	Ongoing hardware checks	Both test and alert error logs cleared in memory or data was transferred to NVRAM.	No corrective action required: indicates that an error code location in NVRAM is now empty.
9062-9069	Ongoing hardware checks	NVRAM failure	1. See Section 6.2. 2. Restore NVRAM data. 3. Replace NVRAM.
9070	Ongoing hardware checks	Not Ventilating signal used in UI/BD communications is not in expected state.	1. See Section 6.2. 2. Replace controller PCB.
9071	Ongoing hardware checks	Not Ventilating signal used in UI/BD communications is not in expected state.	1. See Section 6.2. 2. Replace controller PCB.
9073	Ongoing hardware checks	Transducer autozero timeout error	Replace pressure solenoid PCB.
9074	Ongoing hardware checks	Piston not at expected location at start of inspiration	1. If piston/cylinder was recently replaced, make sure calibration constants were correctly input. 2. Replace motor/encoder. 3. Replace controller PCB. 4. Replace BBU PCB. 5. Replace BBU PCB/ventilator head harness. 6. Check mesh of pinion gear with rack. Remesh as necessary. 7. Replace optoswitches.

Table 6-1: Diagnostic codes (continued)

Code	Software	Possible cause	Corrective action
9075	Ongoing hardware checks	Piston not retracting as expected	1. If piston/cylinder was recently replaced, make sure calibration constants were correctly input. 2. Replace motor/encoder. 3. Replace controller PCB. 4. Replace BBU PCB. 5. Replace BBU PCB/ventilator head harness. 6. Check mesh of pinion gear with rack. Remesh as necessary. 7. Replace optoswitches.
9076	Ongoing hardware checks	Safety valve failed to close	1. Replace safety valve. 2. Replace pressure solenoid PCB.
9077	Ongoing hardware checks	Safety valve failed to open	1. Replace safety valve. 2. Replace pressure solenoid PCB.
9078	Ongoing hardware checks	Not Ventilating signal used in UI/BD communications is not in expected state.	1. See Section 6.2. 2. Replace controller PCB.
9079	Ongoing hardware checks	Not Ventilating signal used in UI/BD communications is not in expected state.	1. See Section 6.2. 2. Replace controller PCB.
9080	Ongoing hardware checks	Not Ventilating signal used in UI/BD communications is not in expected state.	1. See Section 6.2. 2. Replace controller PCB.
9081	Ongoing hardware checks	A high inspiration pressure condition was not stopped by software.	1. Make sure EXHAUST port is not blocked. 2. Use *Sensor data* function to check P_i reading. 3. Replace pressure solenoid PCB. 4. Replace controller PCB. 5. Replace BBU PCB. 6. Make sure safety valve can open. Replace as required.
9082	Ongoing hardware checks	Cylinder pressure out of bounds	1. Use *Sensor data* function to check P_{cyl} reading. 2. Replace pressure solenoid PCB.
9083	Ongoing hardware checks	Piston velocity out of bounds	1. Replace motor/encoder. 2. Replace pressure solenoid PCB. 3. Replace controller PCB.
9084	Ongoing hardware checks	Failure to autozero exhalation pressure transducer	1. Use *Sensor data* function to check P_e reading. 2. Check that autozero solenoid/main ventilator head harness connection is secure. 3. Replace pressure solenoid PCB.

Table 6-1: Diagnostic codes (continued)

Code	Software	Possible cause	Corrective action
9085	Ongoing hardware checks	Failure to autozero cylinder pressure transducer	1. Use *Sensor data* function to check P_{cyl} reading. 2. Check that autozero solenoid/main ventilator head harness connection is secure. 3. Replace pressure solenoid PCB.
9086	Ongoing hardware checks	Inspiration pressure out of bounds	1. Use *Sensor data* function to check P_i reading. 2. Replace pressure solenoid PCB.
9087	Ongoing hardware checks	Exhalation pressure out of bounds	1. Use *Sensor data* function to check P_e reading. 2. Replace pressure solenoid PCB.
9088	Ongoing hardware checks	Exhaled flow out of bounds	1. Make sure room temperature is within specifications. Make sure that ventilator has warmed up and exhaled flow attained a steady-state temperature. 2. Replace flow sensor. 3. Replace pressure solenoid PCB.
9089	Ongoing hardware checks	Oxygen regulator pressure transducer reading out of range	1. Make sure oxygen source pressure is at least 40 psi. 2. Calibrate oxygen regulator pressure transducer. 3. Check for proper installation of oxygen regulator pressure transducer and connection of sensor to pressure solenoid PCB. 4. Replace oxygen regulator pressure transducer. 5. Replace oxygen regulator assembly. 6. Replace pressure solenoid PCB.
9090	Ongoing hardware checks	Motor controller chipset failure	Replace controller PCB.
9091	Ongoing hardware checks	Motor controller chipset failure	Replace controller PCB.
9092	Ongoing hardware checks	Piston motion error	1. Perform gear mesh procedure, as required. 2. If piston scrapes, replace piston/cylinder assembly. 3. Replace motor/encoder. 4. Replace BBU PCB. 5. Replace controller PCB.
9093	Ongoing hardware checks	Unexpected interrupt to motor controller chipset	Replace controller PCB.
9094	Ongoing hardware checks	Unexpected interrupt to motor controller chipset	Replace controller PCB.

Table 6-1: Diagnostic codes (continued)

Code	Software	Possible cause	Corrective action
9095	Ongoing hardware checks	Motor fault reported to motor controller chipset	1. Replace piston/cylinder assembly. 2. Replace BBU PCB. 3. Replace motor/encoder. 4. Replace controller PCB.
9096	Ongoing hardware checks	Piston motion error	1. Verify operation of the home optoswitch. 2. Replace controller PCB. 3. Replace motor/encoder assembly.
9097	Ongoing hardware checks	Piston motion error	1. Verify operation of the end optoswitch. 2. Replace controller PCB. 3. Replace motor/encoder assembly.
9098	Ongoing hardware checks	Motor controller chipset failure	Replace controller PCB.
9099	Ongoing hardware checks	Piston motion error	Replace controller PCB.
9100	Ongoing hardware checks	Piston motion error	Replace controller PCB.
9101	Ongoing hardware checks	Piston motion error	1. Check gear pin. If piston is loose, replace piston/cylinder assembly. 2. Replace BBU PCB.
9102	Ongoing hardware checks	Piston motion error	1. Replace piston/cylinder assembly. 2. Replace BBU PCB.
9103	Ongoing hardware checks	Piston motion error	1. Check that home optoswitch/ventilator head harness connection is secure. 2. Replace controller PCB.
9104	Ongoing hardware checks	Piston motion error	1. Check that end optoswitch/ventilator head harness connection is secure. 2. Replace controller PCB.
9105	Ongoing hardware checks	Piston motion error	Replace controller PCB.
9106	Ongoing hardware checks	Atmospheric pressure out of bounds	1. Make sure ventilator is operating within stated environmental specifications. 2. Replace pressure solenoid PCB.
9107	Ongoing hardware checks	Motor controller chipset failure	Replace controller PCB.
9108	Ongoing hardware checks	Not Ventilating signal used in UI/BD communications is not in expected state.	1. See Section 6.2. 2. Replace controller PCB.
9109	Ongoing hardware checks	Not Ventilating signal used in UI/BD communications is not in expected state.	1. See Section 6.2. 2. Replace controller PCB.

Table 6-1: Diagnostic codes (continued)

Code	Software	Possible cause	Corrective action
9110	Ongoing hardware checks	Exhalation solenoid seems to be stuck open	1. Replace exhalation solenoid. 2. Replace pressure solenoid PCB.
9111	Ongoing hardware checks	CAUTION light control bit not in expected state	1. Replace UI display PCB. 2. Replace controller PCB.
9112	Ongoing hardware checks	CAUTION light control bit not in expected state	1. Replace UI display PCB. 2. Replace controller PCB.
9113	Ongoing hardware checks	Real-time clock failure	Replace controller PCB.
9114	Ongoing hardware checks	Real-time clock failure	Replace controller PCB.
9115-9124	Ongoing hardware checks	Bad NVRAM data or NVRAM	1. See Section 6.2. 2. Restore NVRAM data. 3. Replace NVRAM.
9125	Ongoing hardware checks	Exhalation flow sensor pressure transducer failure	1. Make sure room temperature is within specifications. Make sure that ventilator has warmed up and Txdcr attained a steady state. 2. Replace pressure solenoid PCB.
9126	Ongoing hardware checks	Mismatch between BD and UI microprocessors' inspiration pressure readings	1. Verify that sampling tubes are connected to correct pressure solenoid PCB connectors. 2. Replace pressure solenoid PCB. 3. Replace controller PCB.
9127	Ongoing hardware checks	Mismatch between BD and UI microprocessors' exhalation pressure readings	1. Verify that sampling tubes are connected to correct pressure solenoid PCB connectors. 2. Replace pressure solenoid PCB. 3. Replace controller PCB.
9128	Ongoing hardware checks	Not Ventilating signal used in UI/BD communications is not in expected state.	Replace controller PCB.
9129	Ongoing hardware checks	Not Ventilating signal used in UI/BD communications is not in expected state.	Replace controller PCB.
9130	Ongoing hardware checks	Exhaled flow out of bounds	1. Make sure room temperature is within specifications. Make sure that ventilator has warmed up and exhaled flow attained a steady-state temperature. 2. Replace flow sensor. 3. Replace pressure solenoid PCB.

Table 6-1: Diagnostic codes (continued)

Code	Software	Possible cause	Corrective action
9131	Ongoing hardware checks	Cylinder pressure reading out of range	1. Make sure inspiratory filter outlet is not blocked and air intake filter is not occluded. 2. Replace pressure solenoid PCB.
9132	Ongoing hardware checks	Flow sensor pressure transducer reading too low	1. Make sure room temperature is not too low. Make sure that ventilator has warmed up and Txdcr attained a steady state. 2. Verify that tubes between flow sensor and pressure transducer are securely connected. 3. Make sure EXHAUST port is not blocked. 4. Replace pressure solenoid PCB.
9133	Ongoing hardware checks	Flow sensor pressure transducer reading too low	1. Make sure room temperature is not too low. Make sure that ventilator has warmed up and Txdcr attained a steady state. 2. Verify that tubes between flow sensor and pressure transducer are securely connected. 3. Make sure EXHAUST port is not blocked. 4. Replace pressure solenoid PCB.
9134	Ongoing hardware checks	Flow sensor pressure transducer reading too low	1. Make sure room temperature is not too low. Make sure that ventilator has warmed up and Txdcr attained a steady state. 2. Verify that tubes between flow sensor and pressure transducer are securely connected. 3. Make sure EXHAUST port is not blocked. 4. Replace pressure solenoid PCB.
9135	Ongoing hardware checks	Flow sensor pressure transducer reading too high	1. Make sure room temperature is not too high. 2. Verify that tubes between flow sensor and pressure transducer are securely connected. 3. Make sure EXHAUST port is not blocked. 4. Replace pressure solenoid PCB.
9138	Ongoing hardware checks	+24 V to UI display PCB too low	1. Replace UI display PCB. 2. Replace controller PCB.
9139	Ongoing hardware checks	+24 V to UI display PCB too high	1. Replace UI display PCB. 2. Replace controller PCB.
9140	Ongoing hardware checks	+5 V to UI display PCB too low	1. Replace UI display PCB. 2. Replace controller PCB.

Table 6-1: Diagnostic codes (continued)

Code	Software	Possible cause	Corrective action
9141	Ongoing hardware checks	+5 V to UI display PCB too high	1. Replace UI display PCB. 2. Replace controller PCB.
9142	Ongoing hardware checks	Software/UI display PCB revision mismatch	1. Make sure UI display PCB is for a *700 Series Ventilator System*. 2. Replace UI display PCB. 3. Replace controller PCB.
9143	Ongoing hardware checks	Software/UI display PCB revision mismatch	1. Make sure UI display PCB is for a *700 Series Ventilator System*. 2. Replace UI display PCB. 3. Replace controller PCB.
9144	Ongoing hardware checks	+1.2 V reference from pressure solenoid PCB too low	1. Replace pressure solenoid PCB. 2. Replace controller PCB.
9145	Ongoing hardware checks	+1.2 V reference from pressure solenoid PCB too high	1. Replace pressure solenoid PCB. 2. Replace controller PCB.
9146	Ongoing hardware checks	+15 V from pressure solenoid PCB too low	1. Replace pressure solenoid PCB. 2. Replace controller PCB.
9147	Ongoing hardware checks	+15 V from pressure solenoid PCB too high	1. Replace pressure solenoid PCB. 2. Replace controller PCB.
9148	Ongoing hardware checks	-15 V from pressure solenoid PCB too low	1. Replace pressure solenoid PCB. 2. Replace controller PCB.
9149	Ongoing hardware checks	-15 V from pressure solenoid PCB too high	1. Replace pressure solenoid PCB. 2. Replace controller PCB.
9150	Ongoing hardware checks	+1.2 V reference from pressure solenoid PCB too low	1. Replace pressure solenoid PCB. 2. Replace controller PCB.
9151	Ongoing hardware checks	+1.2 V reference from pressure solenoid PCB too high	1. Replace pressure solenoid PCB. 2. Replace controller PCB.
9152	Ongoing hardware checks	+15 V from BBU PCB too low	1. Replace BBU PCB. 2. Replace controller PCB.
9153	Ongoing hardware checks	+15 V from BBU PCB too high	1. Replace BBU PCB. 2. Replace controller PCB.
9154	Ongoing hardware checks	+5 V from BBU PCB too low	1. Replace BBU PCB. 2. Replace controller PCB.
9155	Ongoing hardware checks	+5 V from BBU PCB too high	1. Replace BBU PCB. 2. Replace controller PCB.
9156	Ongoing hardware checks	+5 V to breath delivery motor controller circuits too low	1. Replace pressure solenoid PCB. 2. Replace controller PCB.
9157	Ongoing hardware checks	+5 V to breath delivery motor controller circuits too high	1. Replace pressure solenoid PCB. 2. Replace controller PCB.

Table 6-1: Diagnostic codes (continued)

Code	Software	Possible cause	Corrective action
9158	Ongoing hardware checks	+2.5 V reference to breath delivery motor controller circuits too low	Replace controller PCB.
9159	Ongoing hardware checks	+2.5 V reference to breath delivery motor controller circuits too high	Replace controller PCB.
9160	Ongoing hardware checks	Oxygen regulator pressure transducer reading too low	1. Calibrate oxygen regulator pressure transducer. 2. Replace oxygen regulator pressure transducer. 3. Replace oxygen regulator assembly. 4. Replace pressure solenoid PCB.
9161	Ongoing hardware checks	Oxygen regulator pressure transducer reading too high	1. Verify that oxygen supply pressure is not too high. 2. Calibrate oxygen regulator pressure transducer. 3. Replace oxygen regulator pressure transducer. 4. Replace oxygen regulator assembly. 5. Replace pressure solenoid PCB.
9162	Ongoing hardware checks	Oxygen regulator pressure transducer reading too low	1. Calibrate oxygen regulator pressure transducer. 2. Replace oxygen regulator pressure transducer. 3. Replace oxygen regulator assembly. 4. Replace pressure solenoid PCB.
9163	Ongoing hardware checks	Oxygen regulator pressure transducer reading too high	1. Verify that oxygen supply pressure is not too high. 2. Calibrate oxygen regulator pressure transducer. 3. Replace oxygen regulator pressure transducer. 4. Replace oxygen regulator assembly. 5. Replace pressure solenoid PCB.
9164	Ongoing hardware checks	Safety valve stuck closed	1. Check that safety valve/ventilator head harness connection is secure. 2. Replace safety valve. 3. Replace pressure solenoid PCB.
9165	Ongoing hardware checks	Safety valve stuck closed	1. Check that safety valve/ventilator head harness connection is secure. 2. Replace safety valve. 3. Replace pressure solenoid PCB.

Table 6-1: Diagnostic codes (continued)

Code	Software	Possible cause	Corrective action
9166	Ongoing hardware checks	Atmospheric pressure measurement out of range	1. Make sure ventilator is operating within stated environmental specifications. 2. Verify that tube between inspiration manifold and inspiration pressure transducer is securely connected. 3. Replace pressure solenoid PCB. 4. Replace controller PCB.
9167	Ongoing hardware checks	Atmospheric pressure measurement out of range	1. Make sure ventilator is operating within stated environmental specifications. 2. Verify that tube between inspiration manifold and inspiration pressure transducer is securely connected. 3. Replace pressure solenoid PCB. 4. Replace controller PCB.
9168	Ongoing hardware checks	Motor controller chipset failure	Replace controller PCB.
9169	Ongoing hardware checks	Piston did not move forward for 3 consecutive breaths	1. Run SST or EST to make sure ventilator is capable of moving piston. 2. Check harness from controller PCB to motor/encoder. 3. Replace controller PCB. 4. Replace motor/encoder assembly.
9170	Ongoing hardware checks	Piston did not move forward for 3 consecutive breaths	1. Run SST or EST to make sure ventilator is capable of moving piston. 2. Check harness from controller PCB to motor/encoder. 3. Replace controller PCB. 4. Replace motor/encoder assembly.
9171	Ongoing hardware checks	EPROM on pressure solenoid PCB uninitialized or data corrupted	Replace pressure solenoid PCB.
9172	Ongoing hardware checks	EPROM on pressure solenoid PCB uninitialized or data corrupted	Replace pressure solenoid PCB.
9173	Ongoing hardware checks	NVRAM failure	1. Replace NVRAM. 2. Replace controller PCB.
9174	Ongoing hardware checks	NVRAM failure	1. Replace NVRAM. 2. Replace controller PCB.
9175	Ongoing hardware checks	NVRAM failure	1. Replace NVRAM. 2. Replace controller PCB.
9176	Ongoing hardware checks	NVRAM failure	1. Replace NVRAM. 2. Replace controller PCB.

Table 6-1: Diagnostic codes (continued)

Code	Software	Possible cause	Corrective action
9177-9180	POST	NVRAM failure	1. Replace NVRAM. 2. Replace controller PCB.
9181	Ongoing hardware checks	The voltage used to identify the *740/760* user interface is out of range.	1. Check all cable connections between the user interface and controller PCB. 2. Replace the user interface. 3. Replace the controller PCB.
9182-9185	POST	NVRAM failure	1. Replace NVRAM. 2. Replace controller PCB.
9186	Ongoing hardware checks	Bad DAC value during P_e autozero	Replace controller PCB.
9187	Ongoing hardware checks	Bad DAC value during P_{cyl} autozero	Replace controller PCB.
10000	Interrupt routines	Software error	See Section 6.2.
10001	Interrupt routines	Software error	See Section 6.2.
10002	Interrupt routines	1. Microcontroller failure 2. Software error	1. Replace controller PCB. 2. See Section 6.2.
10003	Interrupt routines	Memory or microcontroller failure	Replace controller PCB.
10004	Interrupt routines	Microcontroller failure	Replace controller PCB.
10005	Interrupt routines	Microcontroller failure	Replace controller PCB.
10006	Interrupt routines	1. Software error 2. Microcontroller failure	1. See Section 6.2. 2. Replace controller PCB.
10007	Interrupt routines	1. Software error 2. Hardware failure	1. See Section 6.2. 2. Replace controller PCB.
10008	Interrupt routines	1. Software error 2. Hardware failure	1. See Section 6.2. 2. Replace controller PCB.
10009	Interrupt routines	1. Software error 2. Hardware failure	1. See Section 6.2. 2. Replace controller PCB.
10010	Interrupt routines	Power was lost immediately after ventilator power was switched on.	1. Replace power supply. 2. Replace BBU PCB.
10011	Interrupt routines	Power was lost immediately after ventilator power was switched on.	1. Replace power supply. 2. Replace BBU PCB.
11000	SST/EST	Inspiration pressure out of bounds	Replace pressure solenoid PCB.
11001	SST/EST	Exhalation pressure out of bounds	1. Verify the ports were blocked correctly during testing. 2. Replace pressure solenoid PCB.

Table 6-1: Diagnostic codes (continued)

Code	Software	Possible cause	Corrective action
11002	SST/EST	Exhaled flow out of bounds	1. Make sure room temperature is within specifications. Make sure that ventilator has warmed up and exhaled flow attained a steady-state temperature. 2. Replace flow sensor. 3. Replace pressure solenoid PCB.
11003-11015	SST/EST	Software error	See Section 6.2.
11016	SST/EST	Inspiration pressure out of bounds	1. Verify the ports were blocked correctly during testing. 2. Replace pressure solenoid PCB.
11017	SST/EST	Exhalation pressure out of bounds	1. Verify the ports were blocked correctly during testing. 2. Replace pressure solenoid PCB.
11018	SST/EST	Exhaled flow out of bounds	1. Make sure room temperature is within specifications. Make sure that ventilator has warmed up and exhaled flow attained a steady-state temperature. 2. Replace flow sensor. 3. Replace pressure solenoid PCB.
11019-11131	SST/EST	Software error	See Section 6.2.
11132	SST/EST	Software or motor/encoder error	1. See Section 6.2. 2. If piston/cylinder was recently replaced, make sure calibration constants were correctly input. 3. Check mesh of pinion gear with rack. Remesh as necessary. 4. Replace motor/encoder. 5. Replace controller PCB. 6. Replace BBU PCB. 7. Replace BBU PCB/ventilator head harness. 8. Replace optoswitches.

Table 6-1: Diagnostic codes (continued)

Code	Software	Possible cause	Corrective action
11133	SST/EST	Software or motor/encoder error	1. See Section 6.2. 2. If piston/cylinder was recently replaced, make sure calibration constants were correctly input. 3. Check mesh of pinion gear with rack. Remesh as necessary. 4. Replace motor/encoder. 5. Replace controller PCB. 6. Replace BBU PCB. 7. Replace BBU PCB/ventilator head harness. 8. Check mesh of pinion gear with rack. Remesh as necessary. 9. Replace optoswitches.
11134	SST/EST	Software or motor/encoder error	1. See Section 6.2. 2. If piston/cylinder was recently replaced, make sure calibration constants were correctly input. 3. Check mesh of pinion gear with rack. Remesh as necessary. 4. Replace motor/encoder. 5. Replace controller PCB. 6. Replace BBU PCB. 7. Replace BBU PCB/ventilator head harness. 8. Check mesh of pinion gear with rack. Remesh as necessary. 9. Replace optoswitches.
11135-11143	SST/EST	Software error	See Section 6.2.
11144	SST/EST	EST failed, and a VENT INOP condition was declared.	See previous diagnostic codes in log for corrective actions. Repair ventilator and rerun EST.
11145	SST/EST	Software error	See Section 6.2.
11146	SST/EST	Software error	See Section 6.2.
11147	SST/EST	SST failed, and a VENT INOP condition was declared.	See previous diagnostic codes in log for corrective actions. Repair ventilator and rerun EST.

Table 6-1: Diagnostic codes (continued)

Code	Software	Possible cause	Corrective action
11148	SST/EST	Software or motor/encoder error	1. If piston/cylinder was recently replaced, make sure calibration constants were correctly input. 2. Replace motor/encoder. 3. Replace controller PCB. 4. Replace BBU PCB. 5. Replace BBU PCB/ventilator head harness. 6. Check mesh of pinion gear with rack. Remesh as necessary. 7. Replace optoswitches.
11149-11194	SST/EST	Software error	See Section 6.2.
11195	SST/EST	Illegal value in tubing type field in NVRAM	1. Rerun SST. 2. Replace NVRAM.
11196	SST/EST	Software error	See Section 6.2.
11197	SST/EST	Software error	See Section 6.2.
11198	SST/EST	Software error	See Section 6.2.
11199	SST	Software error	See Section 6.2.
11200	EST	Failure to zero exhalation flow sensor pressure transducer	1. Replace exhalation flow sensor. 2. Replace pressure solenoid PCB.
11201, 11202	Communications test	Software error	See Section 6.2.
11203	Calibration	Software error	See Section 6.2.
11204	Calibration/EST	Software error	See Section 6.2.
11205	EST	Software error	See Section 6.2.
11206-11211	Battery load test	Software error	See Section 6.2.
11212, 11213	Communications test	Software error	See Section 6.2.
11214	SST/EST	Software error	See Section 6.2.
11215	SST	Software error	See Section 6.2.
11216-11219	Calibration	Software error	See Section 6.2.
12000	Communications routines	Software error	See Section 6.2.
12001	Communications routines	Software error	See Section 6.2.

Table 6-1: Diagnostic codes (continued)

Code	Software	Possible cause	Corrective action
12002	Communications routines	Software error	See Section 6.2.
12003	Communications routines	Corrupt data packet	1. Verify communications configuration on PC side. 2. Check communications cabling.
12004	Communications routines	Corrupt data packet. Five unsuccessful attempts were made to transmit it.	1. Verify communications configuration on PC side. 2. Check communications cabling.
12005	Communications routines	Software error	See Section 6.2.
12006	Communications routines	Communications failure	1. Verify communications configuration on PC side. 2. Check communications cabling.
12007	Communications routines	Communications failure	1. Verify communications configuration on PC side. 2. Check communications cabling.
12008	Communications routines	Communications failure	1. Verify communications configuration on PC side. 2. Check communications cabling.
12009	Communications routines	Communications failure	1. Verify communications configuration on PC side. 2. Check communications cabling.
12010	Communications routines	Communications failure	1. Verify communications configuration on PC side. 2. Check communications cabling.
12011	Communications routines	Communications failure	1. Verify communications configuration on PC side. 2. Check communications cabling.
12012	Communications routines	Software error	See Section 6.2.
12013	Communications routines	Communications failure	Replace controller PCB.
12014	Communications routines	Software error	See Section 6.2.
13000	Ventilator status	Ventilator reset occurred while entering SST	See Section 6.3.
13001	Ventilator status	Ventilator reset occurred while entering EST	See Section 6.3.
13002	Ventilator status	Ventilator reset occurred during EST	See Section 6.3.

Table 6-1: Diagnostic codes (continued)

Code	Software	Possible cause	Corrective action
13003	Ventilator status	Ventilator reset occurred during SST	See Section 6.3.
13004	Ventilator status	Ventilator reset occurred during calibration	See Section 6.3.
13005	Ventilator status	Ventilator reset occurred in standby mode	See Section 6.3.
13006	Ventilator status	Ventilator reset occurred in normal ventilation mode	See Section 6.3.
13007	Ventilator status	Ventilator reset occurred while waiting for user to confirm settings	See Section 6.3.
13008	Ventilator status	SST passed	None required.
13009	Ventilator status	SST incomplete	None required.
13010	Ventilator status	SST fault	None required.
13011	Ventilator status	SST failure	None required.
13012	Ventilator status	EST passed	None required.
13013	Ventilator status	EST incomplete	None required.
13014	Ventilator status	EST fault	None required.
13015	Ventilator status	EST failure	None required.
13016	Ventilator status	Ventilator reset occurred in normal ventilation mode	See Section 6.3.
13017	Ventilator status	Ventilator reset occurred while waiting for user to confirm settings	See Section 6.3.
13018	Ventilator status	SST failed and ventilator restarted with MENU key pressed down, causing the ventilator to enter VENT INOP	None required.
13019	Ventilator status (technical alert -- ABNORMAL RESTART)	A field in the setting area of NVRAM is corrupted (for example, bad NVRAM data downloaded to ventilator).	The ventilator resets, returns settings to default values, and stores the error in NVRAM. Check and confirm settings, including alarms.

Table 6-1: Diagnostic codes (continued)

Code	Software	Possible cause	Corrective action
14000	Communications failure	An invalid request was received on Port A or Port B	1. Check that external communications device is valid for use with the *700 Series* Ventilator. 2. Check all cable connections between the Communications panel, Communications option assembly, and controller PCB. 3. Replace Communications option assembly.
14001-14xxx	Communications failure	Software error	See Section 6.2.

SECTION 7

Alarm messages

This section describes how to respond to ventilator alarms. It also lists, in alphabetic order, messages displayed by the ventilator when it detects alarm conditions.

7.1 Alarm classifications

Alarms in the *700 Series* Ventilators are classified by priority (*high-priority* or *medium-priority*); this classification determines how the ventilator responds (Table 7-1). Some alarms are triggered by a ventilator setting or patient condition, and they can occur in the usual course of patient care. Others are triggered by the ventilator's built-in ongoing tests (BIOT) and may indicate that the ventilator requires service; some of these are known as *technical alerts*. When the ventilator declares a technical alert, it not only displays a message, but it also places an associated diagnostic code into the alert log (Section 4.1.4).

Table 7-1: How the ventilator responds to alarm conditions

Priority	Meaning	Displays	Audible alarm
High	Requires immediate attention to ensure patient safety	Red ALARM indicator flashes. Message in message window.	Repeating sequence of three, then two beeps
Medium	Requires prompt attention	Yellow CAUTION indicator flashes. Message in message window.	Repeating sequence of three beeps

NOTE:

The highest-priority active alarm always flashes on the first line of the message window. If no alarm is active, the first line displays the highest-priority alarm that was automatically reset. You can use the menu function to view all remaining active and autoreset alarms (see the *700 Series Ventilator System Operator s Manual* for more information on the MENU key).

7.2 Responding to alarms

1. Silence the audible alarm for 2 minutes (where possible) by pressing the alarm silence key.
2. Correct the condition, if necessary, referring to Table 7-2. You may want to check the contents of the alert and test logs (accessible through the service menu, Section 4.2) for related diagnostic codes. These procedures are sequenced to correct the most probable malfunction or to present the most efficient corrective action first. The proposed fixes listed, however, may not always correct the particular problem.

NOTE:

Use the service menu *Sensor data* function (Section 4.2.1) to help confirm the failure of suspect components.

3. If necessary, clear the message or reset the alarm by pressing the alarm reset key (see Table 7-2). Unless otherwise indicated, alarms are reset automatically when the triggering condition is eliminated. For specifics about how alarm silencing and alarm resetting works, see the *700 Series Ventilator System Operator's Manual.*

NOTE:

A temperature-related technical alert may be the first sign of a hardware failure. It may signal a more serious condition that will cause the ventilator to be reset.

Table 7-2: Alarm messages

When you see this message:	It means...	Do this...
ABNORMAL RESTART (no diagnostic code logged)	High-priority alarm. The ventilator was reset, typically due to a ventilator check detecting an error condition. If the ventilator detects three such conditions in 24 operating hours, a ventilator inoperative condition is declared. Alarm does not autoreset; you must press alarm reset key.	Review alert and test logs to determine cause of reset. Service as necessary. NOTE: If the ventilator was reset under software control, a diagnostic code will be logged.
AIR INTAKE ABSENT (diagnostic code 6037)	High-priority alarm. Technical alert. Air intake filter switch open. Alarm does not autoreset; you must press alarm reset key.	1. Verify that air intake filter is installed and that it engages air intake filter switch. 2. Check secureness of air intake filter switch/ventilator head harness connection. 3. Replace air intake filter. 4. Replace air intake filter switch. 5. Replace pressure solenoid PCB.
AIR INTAKE BLOCKED (diagnostic code 6021)	High-priority alarm. Technical alert. Ventilator has detected above-normal resistance at air intake filter during POST after power switched on. Alarm does not autoreset; you must press alarm reset key.	1. Check patient. 2. Check for visible occlusions (for example, a curtain, clothing, or furniture blocking air intake). 3. Replace air intake filter.
APNEA (no diagnostic code logged)	High-priority alarm. Patient has not triggered a breath within apnea interval (can only occur in SPONT mode). Autoreset when patient triggers 2 consecutive breaths.	1. Check patient. 2. Consider switching from SPONT mode.

Table 7-2: Alarm messages (continued)

When you see this message:	It means...	Do this...
BATTERY FUSE FAILED (diagnostic code 6020)	High-priority alarm. Technical alert. Open circuit detected in internal battery output. Alarm does not autoreset; you must press reset key. Once reset, alarm is not reannunciated.	1. Make sure internal battery was not removed during operation. 2. Replace internal battery.
BAT NOT CHARGING (diagnostic code 6006)	High-priority alarm. Technical alert. Battery voltage has not increased during past hour. Alarm does not autoreset; you must press alarm reset key.	1. Check connections and charge of batteries. 2. Replace applicable battery. 3. Replace BBU PCB.
CONTACT SERVICE (diagnostic code 6026)	High-priority alarm. Technical alert. Flow sensor offset has changed by an unexpectedly large value. Alarm does not autoreset.	1. Verify that tubes between flow sensor and pressure transducer are securely connected. 2. Make sure EXHAUST port is not blocked. 3. Check flow sensor calibration constants. 4. Replace flow sensor. 5. Replace pressure solenoid PCB.
CONTACT SERVICE (diagnostic code 6027)	High-priority alarm. Technical alert. Safety valve should be closed, but measured current is too low. Alarm does not autoreset.	1. Check that safety valve/ventilator head harness connection is secure. 2. Check safety valve resistance (10.5 to 14 Ω). 3. Replace safety valve. 4. Replace pressure solenoid PCB.
CONTACT SERVICE (diagnostic code 6028)	High-priority alarm. Technical alert. Safety valve should be closed, but measured current is too high. Alarm does not autoreset.	1. Check that safety valve/ventilator head harness connection is secure. 2. Check safety valve resistance (10.5 to 14 Ω). 3. Replace safety valve. 4. Replace pressure solenoid PCB.
CONTACT SERVICE (diagnostic code 6029)	High-priority alarm. Technical alert. No current to ALARM light when it should be on. Autoreset on subsequent ALARM light state change, after triggering condition disappears.	1. Replace UI display PCB. 2. Replace controller PCB.
CONTACT SERVICE (diagnostic code 6030)	High-priority alarm. Technical alert. There is current to ALARM light when it should be off. Autoreset on subsequent ALARM light state change, after triggering condition disappears.	1. Replace UI display PCB. 2. Replace controller PCB.

Table 7-2: Alarm messages (continued)

When you see this message:	It means...	Do this...
CONTACT SERVICE (diagnostic code 6031)	High-priority alarm. Technical alert. No current to CAUTION light when it should be on. Autoreset on subsequent CAUTION light state change, after triggering condition disappears.	1. Replace UI display PCB. 2. Replace controller PCB.
CONTACT SERVICE (diagnostic code 6032)	High-priority alarm. Technical alert. There is current to CAUTION light when it should be off. Autoreset on subsequent CAUTION light state change, after triggering condition disappears.	1. Replace UI display PCB. 2. Replace controller PCB.
CONTACT SERVICE (diagnostic code 6033)	High-priority alarm. Technical alert. Battery current low. Autoreset when battery current within range.	1. Replace appropriate battery. 2. Replace BBU PCB. 3. Replace controller PCB.
CONTACT SERVICE (diagnostic code 6034)	High-priority alarm. Technical alert. Battery current high. Autoreset when battery current within range.	1. Replace appropriate battery. 2. Replace BBU PCB. 3. Replace controller PCB.
CONTACT SERVICE (diagnostic code 6035)	High-priority alarm. Technical alert. PEEP pump current low. Autoreset when PEEP pump current within range.	1. Verify that resistance of PEEP pump is between 12 and 15 Ω measured when pump is at ambient temperature. If it is not replace pump. 2. Check continuity of wiring to PEEP pump. Replace harness if necessary. 3. Replace pressure solenoid PCB. 4. Replace BBU PCB. 5. Replace controller PCB.
CONTACT SERVICE (diagnostic code 6036)	High-priority alarm. Technical alert. PEEP pump current high. Autoreset when PEEP pump current within range.	1. Verify that resistance of PEEP pump is between 12 and 15 Ω measured when pump is at ambient temperature. If it is not replace pump. 2. Check continuity of wiring to PEEP pump. Replace harness if necessary. 3. Replace pressure solenoid PCB. 4. Replace BBU PCB. 5. Replace controller PCB.
CONTACT SERVICE (diagnostic code 6038)	High-priority alarm. Technical alert. NVRAM failure. Alarm does not autoreset.	1. Replace NVRAM. 2. Replace controller PCB.

Table 7-2: Alarm messages (continued)

When you see this message:	It means...	Do this...
CONTACT SERVICE (diagnostic codes 6043-6046)	High-priority alarm. Technical alert. BBU signal conflict: signals indicate both battery and AC power operation. Alarm does not autoreset.	1. Verify AC power to the ventilator. 2. Verify battery voltage. 3. Check that connections between the BBU and controller PCBs are secure. 4. Replace BBU PCB. 5. Replace controller PCB.
CONTINUOUS HI PRES (diagnostic code 6003)	High-priority alarm. Technical alert. HIGH PRESSURE alarm is active but circuit pressure has not dropped below HIGH PRESSURE setting. This points to a failure to open the exhalation valve. Alarm does not autoreset. The safety valve opens (the patient breathes room air, unassisted by the ventilator).	1. Check patient; provide alternate ventilation. 2. Make sure EXHAUST port is not blocked. 3. Replace exhalation solenoid. 4. Replace pressure solenoid PCB. 5. Replace exhalation valve.
DELIV GAS HI TEMP (diagnostic code 6018)	High-priority alarm. Technical alert. Inspiration manifold temperature too high. Autoreset when temperature within range.	1. Make sure room temperature is not too high. 2. Check wiring from thermistor to pressure solenoid PCB. 3. Replace inspiration manifold thermistor. 4. Replace pressure solenoid PCB.
DELIV GAS LOW TEMP (diagnostic code 6017)	High-priority alarm. Technical alert. Inspiration manifold temperature too low. Autoreset when temperature within range.	1. Make sure room temperature is not too low. Make sure that ventilator has warmed up and Tdel attained a steady state. 2. Check wiring from thermistor to pressure solenoid PCB. 3. Replace inspiration manifold thermistor. 4. Replace pressure solenoid PCB.
DISCONNECT (no diagnostic code logged)	High-priority alarm. Measured exhaled tidal volume is 15% or less of delivered tidal volume for 4 consecutive breaths. Autoreset when exhaled tidal volume is greater than 15% of delivered tidal volume for 1 breath.	1. Check patient. 2. Check ventilator breathing circuit connections. 3. Make sure flow sensor/pressure transducer tubes are connected. 4. If flow sensor was recently replaced, make sure calibration constants were correctly entered. 5. Replace exhalation flow sensor. 6. Replace pressure solenoid PCB.

Table 7-2: Alarm messages (continued)

When you see this message:	It means...	Do this...
EXH CCT HI TEMP (diagnostic code 6012)	High-priority alarm. Technical alert. Exhalation limb temperature too high. The ventilator continues to annunciate this alarm while the condition persists. Autoreset when temperature within range.	1. Check connections of exhalation heater and thermistor assemblies. 2. Replace exhalation heater assembly. 3. Replace exhalation thermistor assembly. 4. Replace pressure solenoid PCB.
	NOTE: Be aware that spirometry may be affected (monitored values may be higher than actual).	
EXH CCT LOW TEMP (diagnostic code 6011)	High-priority alarm. Technical alert. Exhalation limb temperature too low. The ventilator continues to annunciate this alarm while the condition persists. Autoreset when temperature is within range.	1. Check connections of exhalation heater and thermistor assemblies. 2. Replace exhalation heater assembly. 3. Replace exhalation thermistor assembly. 4. Replace pressure solenoid PCB.
	NOTE: Be aware that spirometry may be affected (monitored values may be lower than actual).	
FAN FAILED ALERT (diagnostic code 6004)	High-priority alarm. Technical alert. Fan filter occluded or fan not operational. The ventilator continues to annunciate this alarm while the condition persists. Alarm does not autoreset; you must press alarm reset key.	1. Make sure main fan is operating. 2. Make sure room temperature is not too low. Make sure that ventilator has warmed up and attained a steady-state temperature (*after* removing the ventilator from its packaging). 3. Make sure ventilator lid is securely closed and that the lid gasket is not torn. 4. Make sure vents in unit are not blocked. 5. Replace fan filter, as necessary. 6. Check secureness of main fan/ ventilator head harness connection. 7. Replace main fan. 8. Replace air flow thermistor assembly.
	NOTE: Diagnostic code 6004 can be caused by a fan that draws no current *or* by insufficient air flow into the ventilator and across the air flow thermistor. If the fan is operating, the cause of this diagnostic code is insufficient air flow into the ventilator.	

Table 7-2: Alarm messages (continued)

When you see this message:	It means...	Do this...
FLO SENSOR HI TEMP (diagnostic code 6014)	High-priority alarm. Technical alert. Temperature at exhalation flow sensor pressure transducer too high. The ventilator continues to annunciate this alarm while the condition persists. Autoreset when temperature within range.	1. Make sure room temperature is not too high. 2. Replace pressure solenoid PCB.
FLO SENSOR LO TEMP (diagnostic code 6013)	High-priority alarm. Technical alert. Temperature at exhalation flow sensor pressure transducer too low. The ventilator continues to annunciate this alarm while the condition persists. Autoreset when temperature within range.	1. Make sure room temperature is not too low. Make sure that ventilator has warmed up and Txdcr attained a steady state. 2. Replace pressure solenoid PCB.
HI BBU TEMP ALERT (diagnostic code 6016)	High-priority alarm. Technical alert. Temperature measured on BBU PCB too high. Autoreset when temperature within range.	1. Make sure power supply fan harness is securely connected. 2. Replace power supply fan. 3. Replace BBU PCB.
HI EX TIDAL VOLUME (no diagnostic code logged)	Medium-priority alarm. Exhaled volume for 3 of 4 consecutive breaths was above HIGH TIDAL VOLUME setting. Autoreset when 3 of 4 consecutive breaths are within alarm setting.	1. Check patient. 2. Consider appropriate HIGH TIDAL VOLUME, TIDAL VOLUME, and SUPPORT PRESSURE settings. 3. If flow sensor was recently replaced, make sure calibration constants were correctly entered. 4. Replace exhalation flow sensor. 5. Replace pressure solenoid PCB.
HI RESP RATE (no diagnostic code logged)	Medium-priority alarm. Monitored respiratory rate higher than HIGH RATE setting. Autoreset when monitored respiratory rate less than or equal to alarm setting.	1. Check patient. 2. Check for ventilator breathing circuit leak that could cause autocycling. 3. Consider appropriate HI RATE, RESPIRATORY RATE, and TRIGGER SENSITIVITY settings. 4. Consider adequacy of ventilatory support and patient comfort. 5. Replace controller PCB.
HI SYS TEMP ALERT (diagnostic code 6010)	High-priority alarm. Technical alert. Temperature inside ventilator enclosure too high. Autoreset when temperature within range.	1. Make sure room temperature is not too high. 2. Make sure vents in unit are not blocked. 3. Make sure main fan is operating properly. Clean or replace fan filter, as necessary. 4. Replace pressure solenoid PCB.

Table 7-2: Alarm messages (continued)

When you see this message:	It means...	Do this...
HIGH PRESSURE (no diagnostic code logged)	High-priority alarm. Two consecutive breaths were truncated because ventilator breathing circuit pressure reached HIGH PRESSURE setting. (Inspiration phase ends and exhalation valve opens to prevent excessive pressure.) Autoreset when circuit pressure is less than alarm setting for 5 breaths. Cannot be silenced if alarm condition persists.	1. Check patient. 2. Check for water in inspiratory limb or for kinked tubing. 3. Consider appropriate HIGH PRESSURE and ventilator settings. 4. Replace pressure solenoid PCB. 5. Replace controller PCB.
KEYBOARD FAILED (diagnostic code 6008)	High-priority alarm. Technical alert. A key was held down longer than expected. Alarm does not autoreset.	1. Verify that keyboard cable is securely connected to UI display PCB. 2. Replace keyboard. 3. Replace controller PCB. 4. Replace UI display PCB.
LO EX TIDAL VOLUME (no diagnostic code logged)	Medium-priority alarm. Monitored tidal volume less than LOW TIDAL VOLUME setting for 3 out of 4 consecutive breaths. If LOW TIDAL VOLUME ALARM setting = 0 and breath type is PCV or PSV, this alarm indicates that monitored tidal volume is less than 3 mL for 3 out of 4 consecutive breaths. Autoreset when monitored value is at least equal to alarm setting for 3 out of 4 consecutive breaths, or (if LOW TIDAL VOLUME = 0 and breath type is PCV or PSV) when monitored value is greater than 3 mL for 3 out of 4 consecutive breaths.	1. Check patient. 2. Consider appropriate LOW TIDAL VOLUME, TIDAL VOLUME, and SUPPORT PRESSURE settings. 3. If flow sensor was recently replaced, make sure calibration constants were correctly entered. 4. Replace exhalation flow sensor. 5. Replace pressure solenoid PCB. 6. Replace controller PCB.
LOSS AC POWER (no diagnostic code logged)	Medium-priority alarm. Loss of ac power, although battery backup available. Autoreset after 2 minutes, or when ac power restored.	1. Restore ac power, if possible. 2. Check LEDs on BBU PCB to determine presence of voltages. Replace BBU PCB, power supply, or power input component as required.

Table 7-2: Alarm messages (continued)

When you see this message:	It means...	Do this...
LOSS OF POWER (diagnostic code 6001)	High-priority alarm. Technical alert. The ac supply was lost and the batteries are so low that all power may be lost. The unit will shut down in 5 minutes. Autoreset when ac power is restored or battery power is restored. Alarm sounds until autoreset and for at least 2 minutes following loss of both battery and ac power.	1. Restore ac power, if possible. 2. Check battery connections. 3. Replace batteries (internal and external, if installed) as necessary. 4. Replace BBU PCB.
	NOTE: Actual battery backup time remaining depends on battery condition and ventilator settings.	
LOW BBU TEMP ALERT (diagnostic code 6015)	High-priority alarm. Technical alert. Temperature measured on BBU PCB too low. Autoreset when temperature within range.	1. Replace BBU PCB. 2. Replace power supply.
LOW EX MINUTE VOLUME (no diagnostic code logged)	Medium-priority alarm. Monitored minute volume less than LOW MINUTE VOLUME setting. Autoreset when monitored value is at least equal to alarm setting.	1. Check patient. 2. Consider appropriate LOW MINUTE VOLUME and ventilator settings.
LOW EXT BATTERY (no diagnostic code logged)	High-priority alarm. Low external battery voltage detected during POST, although ac power is sufficient. This alarm occurs only when the internal battery is also low or missing. Autoreset after 2 minutes or when external battery is replaced. Once reset, alarm is not reannunciated.	1. Verify reliable ac power source. 2. Check external battery connections. 3. Replace external battery. 4. Replace BBU PCB.
LOW INSP PRESSURE (no diagnostic code logged)	High-priority alarm. Monitored circuit pressure never rises above LOW INSP PRESSURE setting during inspiration (this alarm is only active during A/C and SIMV modes). Autoreset when circuit pressure is at least equal to alarm setting during inspiration.	1. Check patient. 2. Check for ventilator breathing circuit disconnect. 3. Consider appropriate LOW INSP PRESSURE and ventilator settings.

Table 7-2: Alarm messages (continued)

When you see this message:	It means...	Do this...
LOW INSP PRESSURE1 (diagnostic code 6023)	High-priority alarm. Technical alert. Exhalation pressure transducer reading (P_e) fell below -40 cmH_2O, possibly due to a patient outdrawing the ventilator's set flow rate. Autoreset when pressure within range.	1. Make sure PEAK FLOW setting is adequate to meet patient's demand. Consider appropriate LOW INSP PRESSURE and ventilator settings. 2. Make sure air intake filter is not occluded. 3. Check reasonableness of P_e reading using *Sensor data* menu while ventilation is occurring. Perform a P_e gain calibration as required. 4. Replace pressure solenoid PCB.
LOW INSP PRESSURE2 (diagnostic code 6024)	High-priority alarm. Technical alert. Inspiration pressure transducer reading (P_i) fell below -40 cmH_2O, possibly due to a patient outdrawing the ventilator's set flow rate. Autoreset when pressure within range.	1. Make sure PEAK FLOW setting is adequate to meet patient's demand. Consider appropriate LOW INSP PRESSURE and ventilator settings. 2. Make sure air intake filter is not occluded. 3. Check reasonableness of P_i and P_a readings using *Sensor data* menu while ventilation is occurring. 4. Replace pressure solenoid PCB.
LOW INSP PRESSURE3 (diagnostic code 6025)	High-priority alarm. Technical alert. Cylinder pressure transducer reading (P_{cyl}) fell below -40 cmH_2O, possibly due to a patient outdrawing the ventilator's set flow rate. Alarm does not autoreset.	1. Make sure PEAK FLOW setting is adequate to meet patient's demand. Consider appropriate LOW INSP PRESSURE and ventilator settings. 2. Make sure air intake filter is not occluded. 3. Check reasonableness of P_{cyl} reading using *Sensor data* menu while ventilation is occurring. Perform a P_{cyl} gain equalization as required. 4. Replace pressure solenoid PCB.
LOW INT BATTERY (no diagnostic code logged)	HIgh-priority alarm. Low internal battery voltage detected during POST, although ac power is sufficient. Autoreset after 2 minutes. Once reset, alarm is not reannunciated.	1. Verify reliable ac power source. 2. Check internal battery connections. 3. Replace internal battery. 4. Replace BBU PCB.
LOW O2 SUPPLY (no diagnostic code logged)	High-priority alarm. Low oxygen supply pressure. Ventilation continues with reduced $\%O_2$. (Alarm is not activated when $\%O_2$ setting is 21%.) Autoreset when sufficient oxygen supply pressure is detected. The ventilator may have been calibrated at a high altitude then moved to a lower altitude.	1. Check patient. 2. Verify integrity of oxygen supply and connections. Increase oxygen supply pressure if necessary. 3. Perform these calibrations: O2 pressure calib, then (if applicable) Reg altitude calib (Section 4.2.3.2.2). 4. Replace oxygen regulator pressure transducer. 5. Replace pressure solenoid PCB.

Table 7-2: Alarm messages (continued)

When you see this message:	It means...	Do this...
LOW RESP RATE (*760* only, no diagnostic code logged)	Medium-priority alarm. The ventilator cannot deliver the current RESPIRATORY RATE setting (insufficient time for piston to retract and deliver next breath). Monitored respiratory rate lower than RESPIRATORY RATE setting by one breath per minute + 10% of the setting. Autoreset after 30 seconds. Pressing alarm reset key immediately disables the alarm and clears the autoreset, and the alarm is not reannunciated unless the condition perists after you change settings.	1. Check patient. 2. Check for ventilator breathing circuit disconnect or occlusion. 3. Consider appropriate RESPIRATORY RATE and other mandatory settings. 4. Consider adequacy of ventilatory support and patient comfort.
LOW SYS TEMP ALERT (diagnostic code 6009)	High-priority alarm. Technical alert. Temperature inside ventilator enclosure too low. Autoreset when temperature within range.	1. Make sure room temperature is not too low. Make sure that ventilator has warmed up and Tbox attained a steady state. 2. Replace pressure solenoid PCB.
MOTOR OVER TEMP (diagnostic code 6002)	High-priority alarm.Technical alert. Motor temperature too high. Autoreset when temperature within range (if within 2 minutes). Escalates to a 9008 condition (causing a ventilator reset) if temperature out of range longer than 2 minutes.	1. Check or replace main fan filter. 2. Check for proper operation of main fan. 3. Replace motor/encoder. 4. Replace controller PCB.
NEBULIZER FAILED (diagnostic code 6040)	Nebulizer failed alert. Power not being supplied to nebulizer.	1. Check cable connection between the communications panel and the nebulizer. 2. Replace cable. 3. Check cable connection between the communications PCB and the controller PCB. 4. Replace cable. 5. Replace communications PCB. 6. Replace nebulizer.
% O2 HIGH (no diagnostic code logged)	High-priority alarm. Measured oxygen percentage more than 10 percentage points above setting for at least 30 seconds. Autoreset when measured $\%O_2$ is within 10 percentage points of setting.	1. Check air intake filter for occlusion. Replace if necessary. 2. Check oxygen supply. 3. Verify that an oxygen sensor is installed. 4. Check remaining sensor life (via service summary) and replace sensor if required. 5. Perform FIO_2 calibration check. 6. Replace pressure solenoid PCB.

Table 7-2: Alarm messages (continued)

When you see this message:	It means...	Do this...
% O2 LOW (no diagnostic code logged)	High-priority alarm. Measured oxygen percentage more than 10 percentage points below setting for at least 30 seconds. Autoreset when measured $\%O_2$ is within 10 percentage points of setting. The ventilator may have been calibrated at a high altitude then moved to a lower altitude.	1. Check patient. 2. Check oxygen supply. 3. Verify that an oxygen sensor is installed. 4. Check remaining sensor life (via service summary) and replace sensor if required. 5. Perform FIO_2 calibration check. 6. Perform these calibrations: O2 pressure calib, then (if applicable) Reg altitude calib (Section 4.2.3.2.2). 7. Replace pressure solenoid PCB.
OCCLUSION (no diagnostic code logged)	High-priority alarm. Ventilator breathing circuit or inspiratory or expiratory filters occluded. Ventilator detects above-normal difference between inspiratory and expiratory pressure transducers. The ventilator enters occlusion cycling mode. Autoreset when the ventilator no longer detects an occlusion.	1. Check patient. 2. Check ventilator breathing circuit and inspiratory and expiratory filters for occlusions or kinks. Empty excess water from tubes. 3. Press the alarm reset key. 4. If this does not resolve the problem, provide alternate ventilation and contact service.
PARTIAL OCCLUSION (no diagnostic code logged)	High-priority alarm. Ventilator breathing circuit or inspiratory or expiratory filters occluded. Ventilator detects above-normal difference between inspiratory and expiratory pressure transducers. Safety valve remains closed, ventilation continues. Autoreset when ventilator fails to detect a partial occlusion for 2 consecutive breaths.	1. Check patient. 2. Check ventilator breathing circuit and inspiratory and expiratory filters for occlusions or kinks. Empty excess water from tubes. 3. Press the alarm reset key. 4. If this does not resolve the problem, provide alternate ventilation and contact service.
REPLACE O2 SENSOR (diagnostic code 6022)	High-priority alarm. Technical alert. Oxygen sensor missing or reading out of range. Alarm does not autoreset; you must press alarm reset key.	1. Make sure an oxygen sensor is installed and securely connected to ventilator head harness. 2. Perform FIO_2 calibration check. 3. Replace oxygen sensor.
SETUP TIME ELAPSED (no diagnostic code logged)	High-priority alarm. At least 30 seconds have elapsed since you pressed a key or turned the knob (occurs at power-on only). Autoreset when you accept proposed settings.	1. Check patient. Be sure to complete ventilator setup before connecting ventilator breathing circuit to patient. 2. Select appropriate ventilator settings.
SERVICE XDUCER (diagnostic code 6019)	High-priority alarm. Technical alert. Exhalation, cylinder, or flow sensor pressure transducer drift. Alarm does not autoreset.	1. Make sure that ventilator has warmed up sufficiently and is at a steady-state temperature. 2. Replace pressure solenoid PCB.

Table 7-2: Alarm messages (continued)

When you see this message:	It means...	Do this...
SPEAKER FAILED (diagnostic code 6007)	High-priority alarm. Technical alert. Main alarm speaker failed and backup alarm sounds. The ventilator continues to annunciate this alarm while the condition persists. Alarm does not autoreset; you must press alarm reset key.	1. Check wiring to speaker. 2. Replace speaker. 3. Replace pressure solenoid PCB.
SWITCH INT BATTERY (no diagnostic code logged)	Medium-priority alarm. Ventilator power source has switched to internal battery. Autoreset after 2 minutes, when ac power is restored, or when external battery is replaced.	1. Restore ac power, if possible. 2. Check external battery connections. 3. Replace external battery, if necessary. 4. Check LEDs on BBU PCB to determine presence of voltages. Replace BBU PCB, power supply, or power input component, as required.
VALVES TEST FAILED (diagnostic code 6039)	Safety valve stuck closed during POST	1. Check state of safety valve during POST. 2. If stuck closed, replace. 3. If safety valve open during POST, replace outlet check valve.